DECEMBER • 1955

PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE
Gulf Publishing Co.

PETROCHEMICAL PROCESS HANDBOOK

•

Production 110
Raw Materials 116
Rubber Boom 120
Processes 123

ADDED "LIFE" FOR YOUR MOTOR FUEL
that's
RETAINED VOLATILITY

Blending WARREN Natural Gasoline with your present high quality motor fuel will give it the RETAINED VOLATILITY essential for superior performance after it reaches the fuel tanks of your customers. You can always depend on Warren's production, transportation, storage and SERVICE for the grade and quantity of NATURAL GASOLINE you want—when and where you want it.

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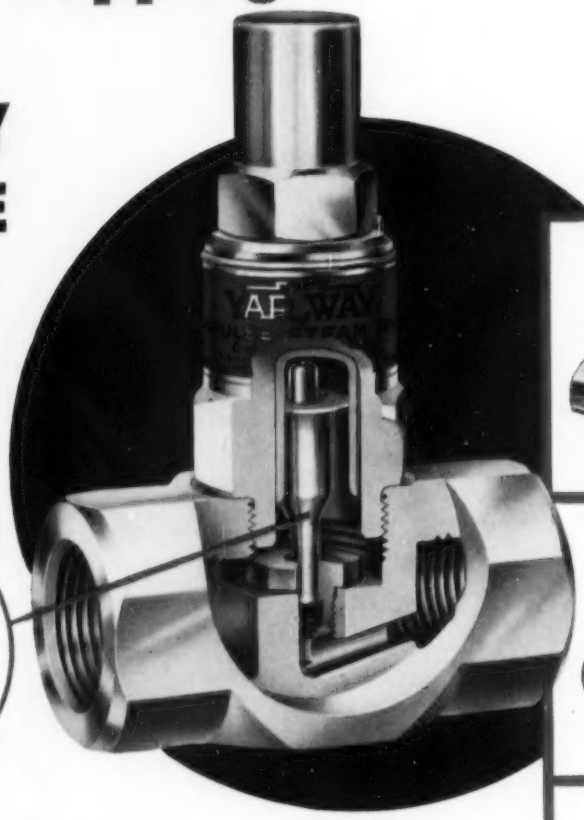
the impulse that revolutionized steam trapping

YARWAY IMPULSE STEAM TRAP



the only moving part

...a small stainless steel valve that literally floats on the condensate load. Gets equipment *hot in a hurry*—and *keeps it hot!*

Twenty years ago YARWAY applied a unique theory of thermodynamics to steam traps—and gave industry the amazing YARWAY Impulse Steam Trap.

Today — over a million YARWAY Impulse Steam Traps later — advantages like the following continue to convert new users, and convince old users to standardize on the YARWAY Impulse:

- **QUICK HEAT-UP AND EVEN TEMPERATURES OF EQUIPMENT**
- **GOOD FOR ALL PRESSURES WITHOUT CHANGE OF VALVE OR SEAT**
- **SMALL SIZE—LIGHT WEIGHT**
- **ONLY ONE MOVING PART**
- **STAINLESS STEEL—minimum maintenance**
- **WON'T FREEZE UP**
- **A COMPLETE LINE of sizes and types for every requirement**
- **IMMEDIATELY AVAILABLE from 270 local Industrial Distributors**

For free Trap Selector, or 24 page Bulletin, write

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128 Mermaid Avenue, Philadelphia 18, Pa.

SERIES 60 and 120

For all *normal* trap requirements, pressures to 400 and 600 psi.

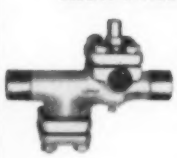
½" No. 20-A

For *light loads* on tracer lines, steam mains, small presses, etc.

SERIES 40

For *heavy loads* requiring extra high capacity steam traps.

INTEGRAL-STRAINER HIGH PRESSURE TRAP



For *high pressures, high temperatures.* (Flanged or welding connections.)

YARWAY **IMPULSE® STEAM TRAP**

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

Volume 34, No. 12 December, 1955

PETROLEUM
REFINER
REFINING | PETROCHEMICALS | NATURAL GASOLINE

PETROCHEMICAL HANDBOOK

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A Quick Look
at This Issue

These handy digests permit checking those articles you want to read first.

PETROCHEMICAL HANDBOOK

☐ **Foreword** . . . The REFINER staff presents its THIRD Annual Petrochemical Issue. In this issue you will find 75 flow diagrams and descriptions of the most timely processes. Each is complete with application, charge, products, operating conditions, yields, and commercial installations. Another FIRST for the REFINER is the presentation of all three Polyethylene manufacturing processes as well as both Glycerine manufacturing processes. The foreword to this outstanding handbook begins on **Page 105.**

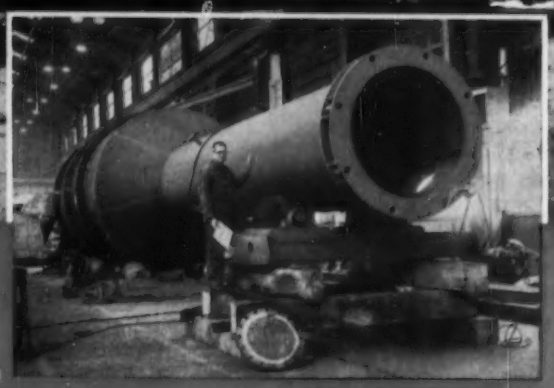
☐ **Production Tomorrow** . . . Petrochemicals are due for another upswing in 1956. Look for the greatest increases in hydrocarbon intermediates, aromatics, hydrocarbon polymers, ammonia, and aliphatic chemicals. To get the complete story on the "whys and wherefores" of this strong and growing industry, turn to **Page 110.**

☐ **Raw Materials Today** . . . Natural gas was considered the ideal starting material for petrochemicals manufacture, but can it last with the rising prices and competition for its use as fuel? There are other abundant raw materials just as good or even better suited for chemical production. These materials have just begun to be utilized. For the past, present and future in this dynamic field, turn to **Page 116.**

☐ **Synthetic Rubber Boom?** . . . It has happened at last. The synthetic rubber industry is privately owned! This new industry has withstood the first eight months of this existence quite well. The toughest competition is the plastics industry. But research and a plentiful supply of new and specialized rubbers could make the race both interesting and profitable. For the future plans of this "young giant" and how its ownership is split, read the article beginning on **Page 120.**

☐ **How Vulnerable Are We?** . . . Four H-bombs could destroy almost half of all the petroleum processing plants in the U. S. A well-directed bomb on the Houston area alone would de-activate more than 5 percent of the people who work in this vital industry. For more interesting facts and arguments favoring peacetime dispersal in industry-saturated areas, see **Page 105.**

Destination... Taiwan!



Custom Fabrication... by BS&B!

No job-site in the world is so far away as to make it impractical to use BS&B's modern fabrication facilities and technical "know-how" to produce the pressure vessels and other specialized equipment needed for the project.

Take the two vessels shown here for example. One is a debutanizer weighing more than 36,000 lbs., and measuring 4' -0" ID x 93' -1" overall length. The other is a 120" x 54" x 34' -0" (tan-tan) vacuum tower weighing more than 33,600 lbs.

Both were fabricated in our Oklahoma City plant for Fluor Corporation, Ltd., from where they were shipped to Taiwan for installation in the Kaohsiung Refinery of the Chinese Petroleum Corporation.

This is by no means an isolated example. Other BS&B "special fabrication" jobs have gone to Canada, South America, Europe and the Middle East.

But wherever your job-site—at home or abroad—you can count on BS&B to do your custom fabrication work *right*... and to deliver it *right on time*, ready for erection and installation!

Why not talk over your next project in strictest confidence with our representative? Write to...

OVER 60 YEARS' EFFICIENCY BS&B RELIABILITY — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

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Single copies of this issue $1. Subscription rates—U. S. and Canada $2 a year; Latin America and overseas $5 a year. PETROLEUM REFINER, published on the 13th of every month, entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act March 3, 1879. Subscriptions restricted to those engaged in refining, natural gasoline or petrochemical industries or service and supply company personnel connected thereto. Advertising rates on application.

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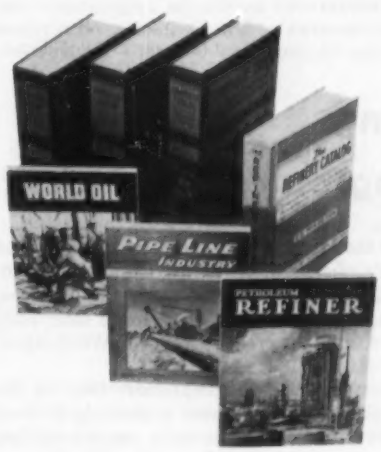


Specialized Oil Publication of
THE GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the refining-natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY for the oil and gas pipe line industry

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

Maintenance—Its Cost

YOU CAN GET the first industry-wide look at what maintenance is costing and what this trend is in PR's January Maintenance Issue. A "first of its kind" survey summary is being compiled for you.

Also you will get a very thorough coverage, from within the industry, on the latest practices in maintenance administration and preventive maintenance. Vital problems such as operations-maintenance coordination and human relations in maintenance will be covered. And, too, how to measure the effectiveness of maintenance operations.

The treatment is going to be such that it will offer valuable information to all phases of the industry, petrochemical, refining and natural gasoline operations.

Since maintenance cost is the prime variable cost in all of the petroleum industry plant operations, you cannot afford to miss the Maintenance Issue. It will help you shift dollars from your costs to your profits.

Gifts or Otherwise

YOU MAY or may not want to use 'em as Christmas gifts, but they wouldn't be too bad, at that.

Here we're speaking of the two latest additions to our stock of Reprints For Sale:

"How to Get Those Top Octanes," by Marshall Sittig and Wayne Warren, a thorough treatment of octane improvement techniques plus a relating comparison of catalytic reforming processes.

PETROLEUM REFINER's Petrochemical Handbook, some 100 pages of process descriptions and an unusual line-up of articles about the industry in general and its future. All of this material appears in this issue, but in the past many have found the separate reprint a handy tool.

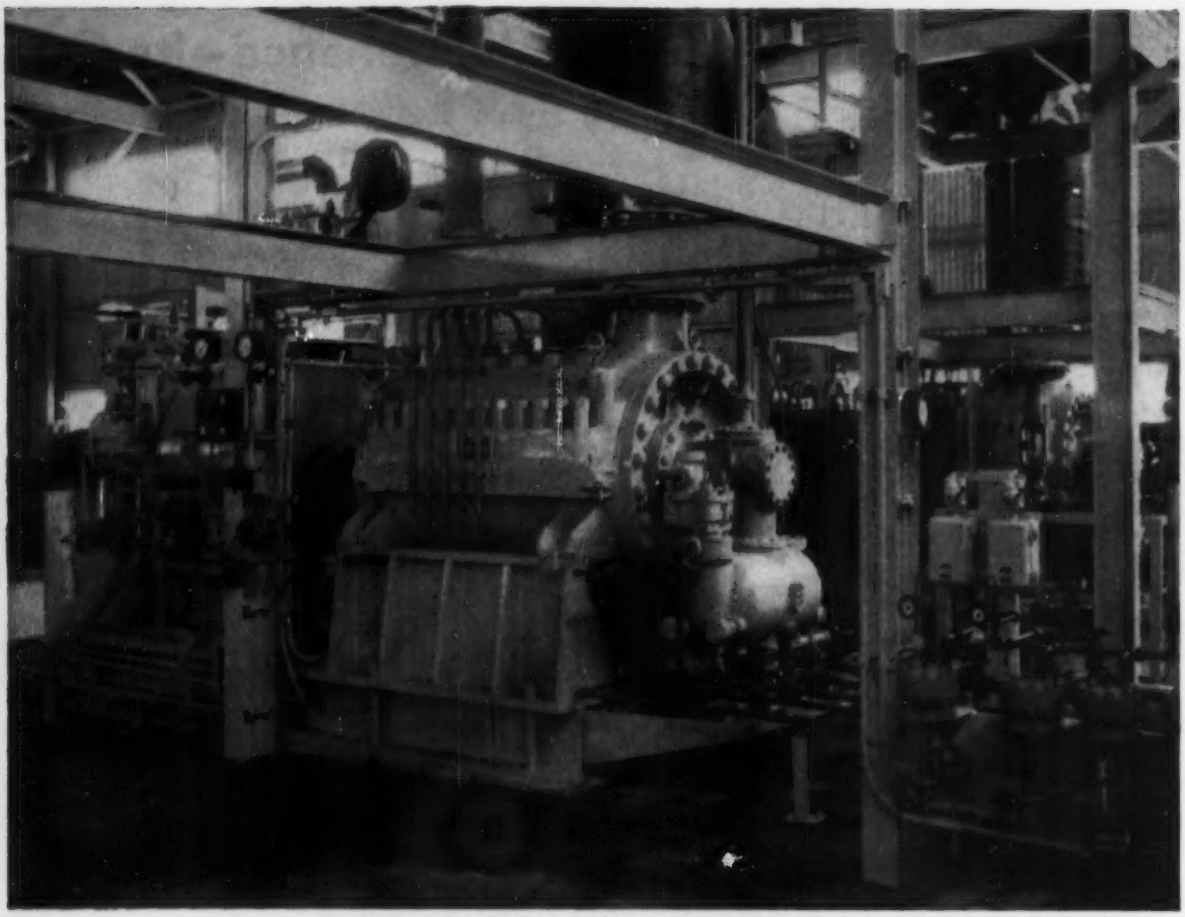
You can get either or both of these by the simple procedure of ordering them at $1 each from Reprint Department, PETROLEUM REFINER, Box 2608, Houston 1, Texas.

August *PR* Had It

Ray P. Dinsmore, vice president in charge of research and development for Goodyear Rubber has announced that the catalyst used in the synthesis of synthetic natural rubber was a combination of aluminum triethyl and cocatalyst as developed by Karl Ziegler of the Max Planck Institute Coal Research in Germany.

This type of polymerization reaction as well as the catalyst is described in the August, 1955, PETROLEUM REFINER. The article "Direct Polymerization of Ethylene and Its Homologues" by Karl Ziegler, is a translation, the completeness of which has drawn commendation from its German publishers and author.

Call that being right on the ball?



ONE OF TWO WORTHINGTON CENTRIFUGAL COMPRESSORS keeping the temperature — and cost — *low* in ammonia processing at Lion Oil Company's plant. This unit cools a copper solution used to scrub NH_3; and chill and condense the compressed NH_3 gas to a liquid state.

Ammonia gets low-cost scrubbing and chilling with Worthington compressors

Every day 20 million cubic feet of natural gas are used in producing 300 tons of anhydrous ammonia at Lion Oil Company's Barton Plant in Luling, Louisiana — and nothing goes to waste!

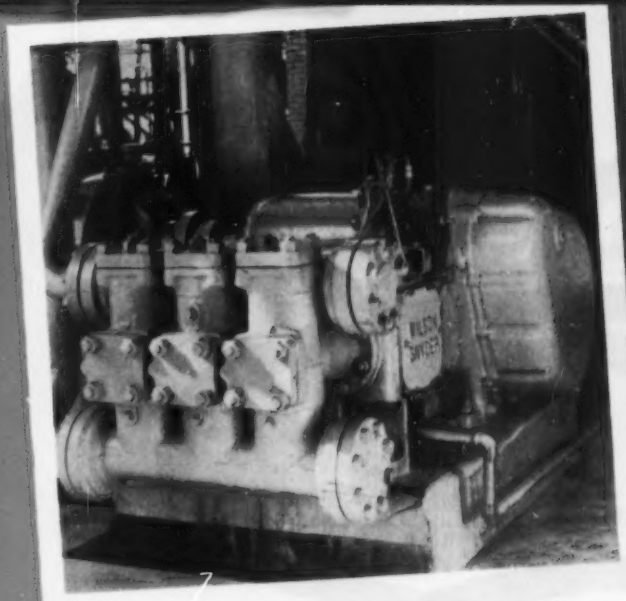
Part of the credit for this efficient operation goes to two new Worthington centrifugal compressors which chill and scrub ammonia gas during the synthetic process. Unlike ordinary compressors, the new Worthington units employ interstage liquid ammonia injection — an exclusive feature that effectively reduces the heat of compression and thereby more efficiently converts velocity energy into pressure.

Choice of the Worthington compressors was based largely on this efficient design which has already introduced new economies into the Barton Plant operation. The centrifugal units, each rated at more than 1300 tons capacity, are powered by reliable Worthington steam turbines.

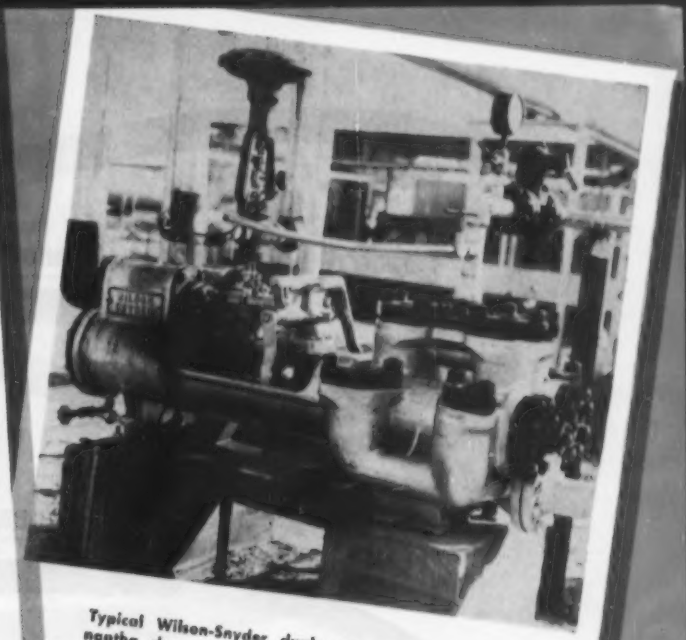
Worthington centrifugal compressors may be the answer to low-cost, high-volume processing in your plant, too. Find out how these units put big chilling jobs on a more profitable basis by writing Worthington Corporation, Air Conditioning & Refrigeration Division, Section A.5.61-PE, Harrison, N.J. A5.61

WORTHINGTON

CLIMATE ENGINEERS TO INDUSTRY, BUSINESS AND THE HOME



Typical Wilson-Snyder triplex plunger power pump in Universal Oil Products Platforming reactor charge service.



Typical Wilson-Snyder duplex steam pump handling naptha charge in an Atlantic Catforming installation.

Wilson-Snyder Reciprocating Pumps
—your best buy for LOW-Capacity, HIGH-Pressure Services

RECIPROCATING pumps offer many money-saving advantages over multistage centrifugals from 20 to 200 gpm when the differential head in feet is over 20 times the gpm.

LOW OPERATING EXPENSE—85 to 90% efficiency over the complete operating range is generally accepted for roller-bearing-equipped power pumps. The efficiency range of 20% to 60% for centrifugal pumps means that the user must have prime movers 425% to 42% larger than required for comparable reciprocating power pumps. *Think what this means in power savings!*

LOW MAINTENANCE EXPENSE — Reciprocating pumps develop high pressure at moderate speed and running clearance, whereas centrifugals depend on high speed at very close running clearances to develop pressure. Maintenance engineers know that grit, welding beads, mill scale, etc. in suction lines and vessels, as well as unstable suction conditions, can cause serious seizures and mechanical seal failures of multistage centrifugal pumps; with costly operating delays and expensive replacements. Why risk such failures to save a little floor space when dependability is your most important need?

EXPERIENCE—For over 75 years, Wilson-Snyder has furnished heavy-duty pumps of the highest quality, and performance records in thousands of refinery installations throughout the United States and foreign countries have established them as the industry's finest pumps. As a builder of both centrifugal and reciprocating types (including power and direct-acting steam) you can be sure of an unbiased recommendation as to which type will best suit your conditions.

Give your nearest "Oilwell" Pump Specialist an opportunity to quote on Wilson-Snyder pumps for your requirements.

OIL WELL SUPPLY
DIVISION UNITED STATES STEEL CORPORATION
Executive Offices—**DALLAS, TEXAS**
with Refinery Equipment Specialists at

Beaumont, Texas		Braddock, Pa.
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USS

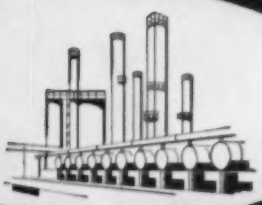
"OILWELL"

TRADE MARK

UNITED STATES STEEL

here
a pressure drop is annoying

here
a pressure drop is expensive



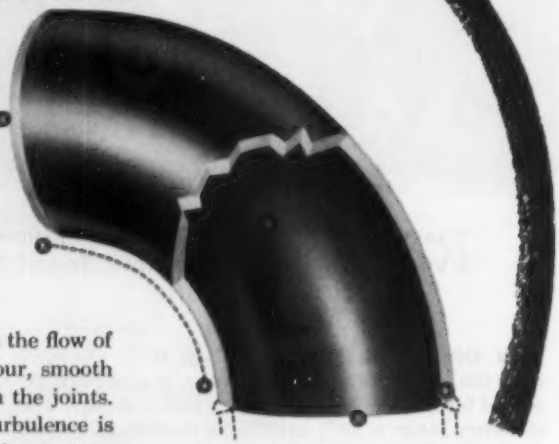
here's how
B&W SEAMLESS ALLOY WELDING FITTINGS ASSURE MINIMUM PRESSURE LOSS!

A CIRCULARITY — True circularity throughout insures accurate alignment when special odd-angle sections are cut. Full diameter throughout protects against pressure loss due to flattened or angular surfaces.

B RADIUS — Uniform gradual change of direction provides smooth even flow — less resistance to directional changes.

C SMOOTH INNER WALLS — No waves or ridges within the fitting to impair flow—no buckling of metal along the short inner curve—no stretching on the outer curve. This prevents premature piping system failure

D SMOOTH JOINTS — Uniform wall thickness, machined bevel ends, and perfect agreement between fitting and pipe sizes assure automatic and perfect alignment. The smooth welded joints present no interruption to flow.



Welding fittings remove all "road blocks" from the flow of material. They present a gentle transition in contour, smooth inner walls free of pockets or crevices within the joints. Flow of materials is speeded, erosion due to turbulence is minimized adding years to the life of the piping system.

This efficient piping flow reduces maintenance costs, reduces pumping power requirements and investment in equipment.

B&W SEAMLESS WELDING FITTINGS
GRADES: Carbon, Alloy and Stainless Steels.
TYPES: Elbows, Tees, Caps, Saddles, Laterals, Nipples, Returns, Flanges, Stub Ends, Reducers, Crosses, Bull Plugs.
SIZES: Complete range of sizes and schedules.

IT PAYS TO LOOK AT THE ADVANTAGES OF USING B&W SEAMLESS WELDING FITTINGS

Welded Construction Takes Less Space—Piping can be nested in corners, or fitted against ceilings, walls or equipment. Dimensional accuracy permits cut-offs at odd angles when necessary.

Whole Sections Can Be Shop-Fabricated—For fast installation, or where working space is limited, entire sections can be shop-fabricated and installed by any qualified welder in a few minutes.

Welded Construction is Easily Insulated — Insulation is simplified by the absence of complex flanged assemblies. Because joints are leakproof, insulation is permanent and maintenance free.

Welded Construction is Permanent — Maintenance costs are kept at a minimum because piping is permanent and leakproof. The strength of the weld approaches that of the pipe itself.

Welded Construction is Simple to Install—Dimensional accuracy of angles, radii, and bevels, assure quick and easy joining. Any qualified welder can do the job efficiently and economically.

Welded Construction is Lightweight—Strength with lightweight permits easy handling in installation. Unwieldy sections can be joined on the ground, and then quickly fastened into position.

THE *NATURAL* SOURCE FOR ALLOY FITTINGS

B&W TUBULAR PRODUCTS DIVISION

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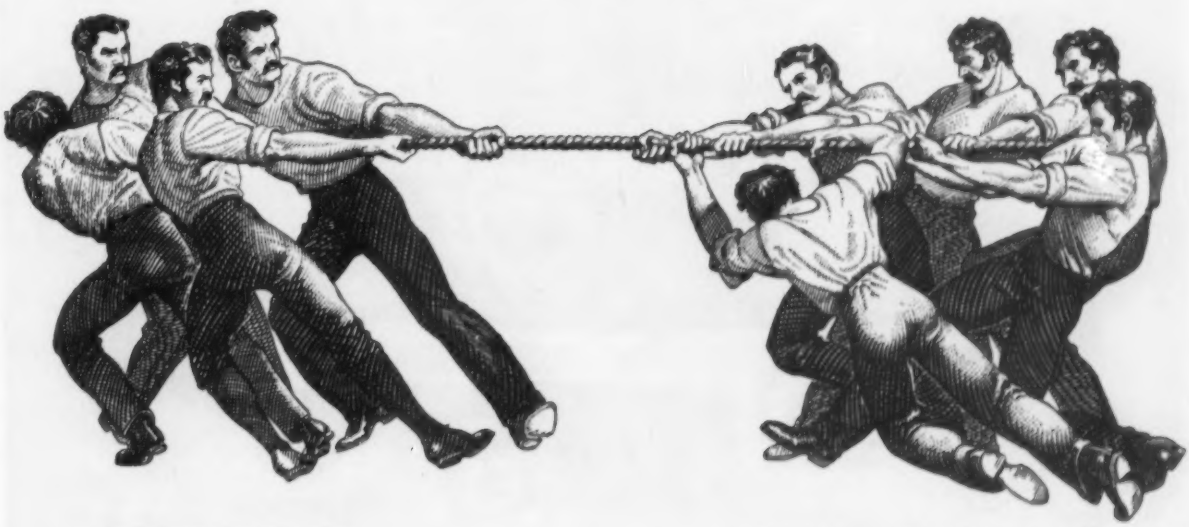
boost production
with the Ljungstrom® Air Preheater

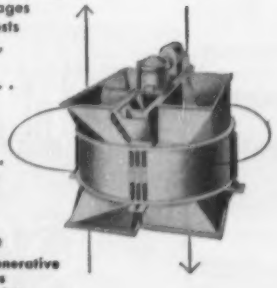
4 *of your units*
can do
the
work of 5



HOW FAST IS "WRITE OFF"?

In most cases, the Ljungstrom installation is quickly written off by increased capacity alone. Write-off time is even less when the other Ljungstrom advantages are considered — saves up to 20% of fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in fuel burning equipment — call or write The Air Preheater Corporation.



Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

Recover waste heat, return it to the furnace as combustion air, and you naturally generate higher flame temperatures . . . increase heat-transfer rates — *which means more through-put.*

That's why four of your present processing units can do the work of five *with Ljungstrom Air Preheaters increasing each unit's output as much as 25%.* One eastern refinery increased the continuous capacity of a pipe still from 16,000 to 18,000/20,000 barrels a day — by modernizing and including a Ljungstrom.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

Which of these 22 tube steels will give you maximum tube life per dollar? *Ask the experts!*

This month's report is on: **2% CR.-MO.**

Has intermediate corrosion resistance in combination with good creep strength and fair resistance to oxidation. For use at temperatures up to 1200° F. in cracking coils, reforming units, heat exchangers, vapor line and hot oil piping, and return-bend forgings for oil heaters.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

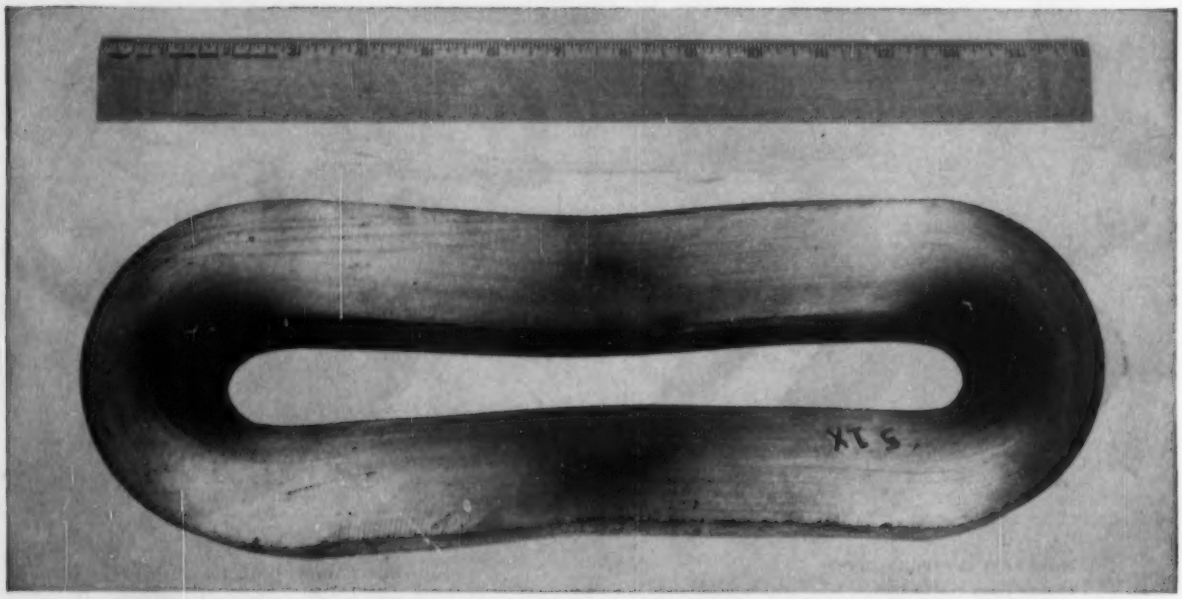
Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

** Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

FOR every high temperature application, there's one tube steel that gives you the best life-cost ratio. One steel best answers your particular set of temperature-pressure-corrosion-oxidation conditions. That's why the Timken Company makes the 24 different high temperature steels shown in the box at left.

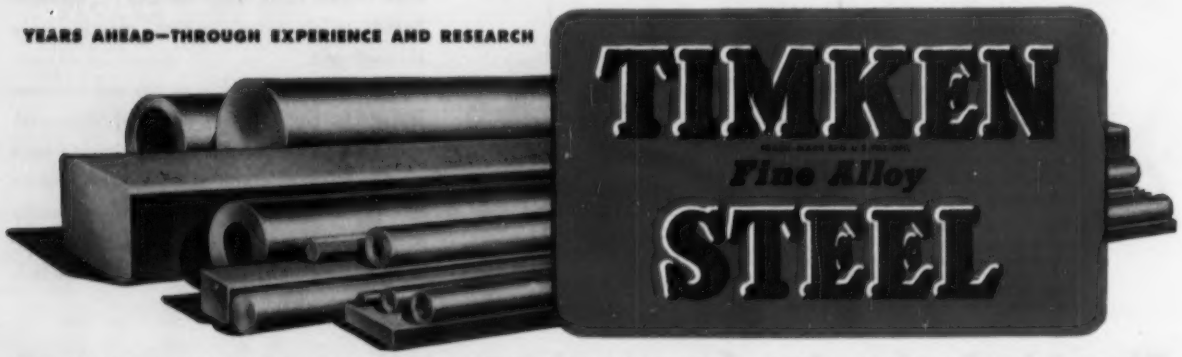
To find the one best steel for each of your applications, ask the Timken Company metallurgists. They're experts. They know how to balance the various factors against cost—and recommend the analysis that gives you maximum tube life per dollar of cost. They've been doing it for 20 years. And remember—regardless of analysis, you get uniform quality in every Timken® tube because we rigidly control quality at every step from melt shop through final inspection.

Put our "RSQ"—Research, Supply, Quality—to work on *your* tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".



Flattened test of 10½" O.D. by 1.580" wall of 18-8 Cb showing the excellent ductility of large, heavy-wall Timken seamless tubing.

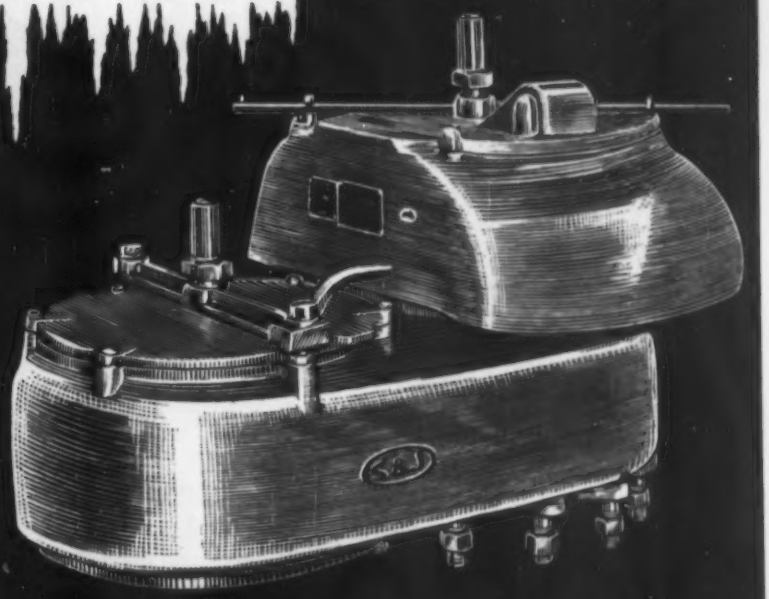
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

FREEZING WEATHER NO PROBLEM

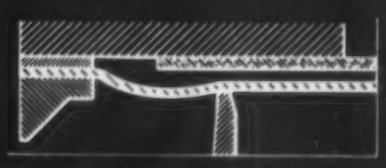
TO S&J "TITE SEAL"



The Shand & Jurs "Tite-Seal" Breather Valve scoffs at freezing winter weather conditions. Its unique pliable diaphragm-pallet is the answer. When supplied with a special diaphragm of Teflon coated fiberglass for extreme freezing hazards, it has been found that only ¼" of water beyond normal valve setting was required to break ice. This has been determined by impartial tests conducted by laboratories, government agencies, and by independent research organizations.

For moderate climatic conditions, the S&J "Tite-Seal" is supplied with a pliable, reinforced synthetic rubber coated diaphragm. This design provides the tightest possible seal through a novel balancing action. When venting, a peeling action between the pallet and the seat overcomes sticking or freezing to a very marked degree. The "Tite-Seal," designated by S&J as Fig. ST-7575, will provide maximum venting dependability for petroleum tanks, no matter what the weather conditions.

The S&J "Tite-Seal" in action. Typical pallet with pliable diaphragm shown. In operation, tank pressure is directed through a port in the diaphragm to a chamber outside the periphery of the seat but inside the periphery of the pallet, producing a slight ballooning which effects a perfectly "Tite-Seal" at all pressures below that for which the pressure pallet of the breather valve is set to open.



Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES

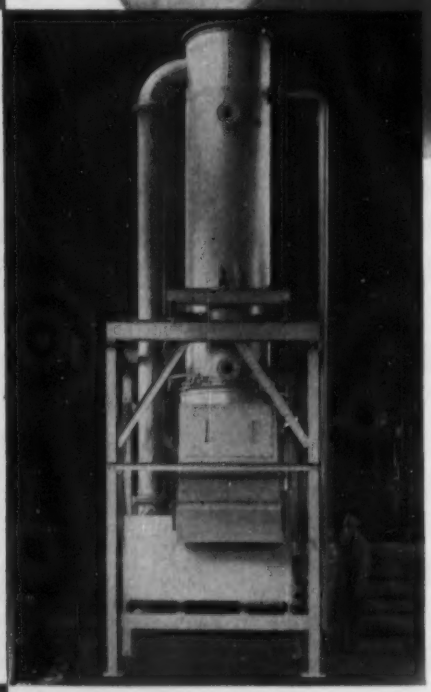
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St. W.
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglington East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

For more data on advertised products, use Readers' Service Cards, last page.

"What is your processing problem?"

*this machine congeals, molds and discharges automatically

*If your process involves a liquid that will solidify when cooled.... ....this machine can do it....then discharge and size the substance.... all automatically



If you have a processing problem, perhaps the Vogt Automatic Tube-Type Molding Machine will provide the answer because it will form and size any liquid that will solidify when cooled, and will discharge by gravity upon heating.

Now in use by major chemical companies, these units have achieved tremendous savings in labor while producing a more uniform product. Also, since the process involves "freezing" or solidifying the substance while it circulates through tubes, the quality of the product is often superior to that of the original charge.

The wide range of uses to which Vogt Tube-Type Molding Machines have been adapted indicates their definite value in the chemical processing field. Adaptation possibilities are virtually unlimited and you may request detailed technical information from our engineers without obligation.

Address Dept. 24-RIPR

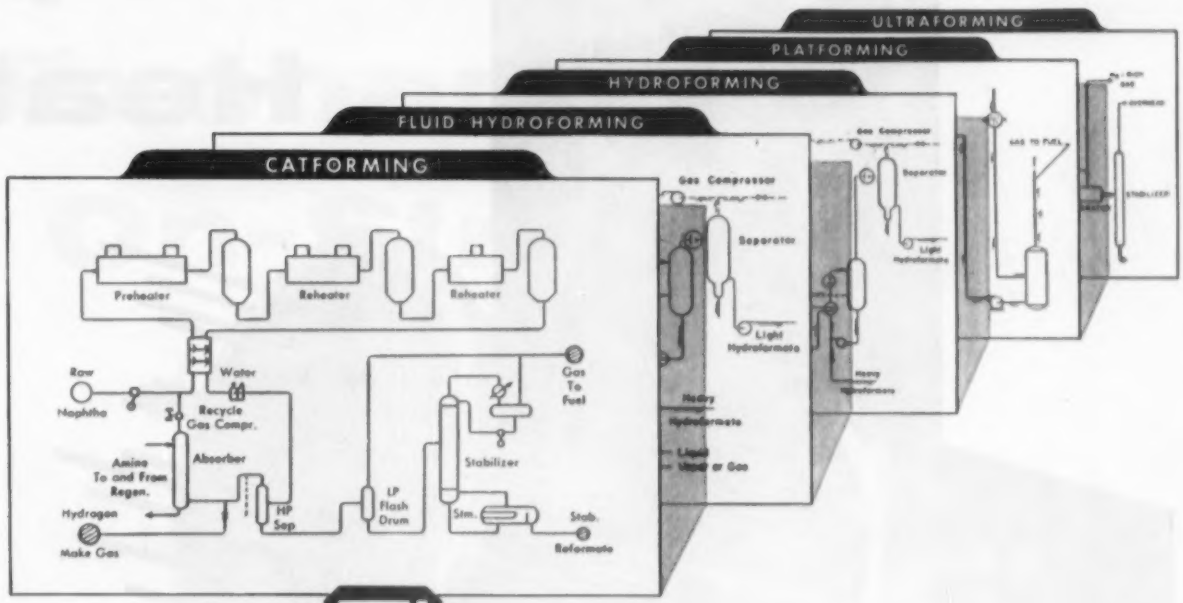
Vogt Automatic Tube-Type

MOLDING MACHINE

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

SALES OFFICES: New York, Philadelphia, Chicago, Cleveland, Cincinnati, St. Louis, Dallas, Charleston, W. Va., San Francisco

which method of
CATALYTIC REFORMING
is best suited to your needs
...FLUID or FIXED BED?



Here's why FW can give you the right answer

...and supply the complete job, too!

The success of catalytic reforming has led to the development of many different methods — both fluid and fixed bed. Selection of the most economical and efficient process for any given installation therefore poses an interesting problem.

Foster Wheeler has completed an extensive economic study of the relative values of the fluid method of catalytic reforming versus the various fixed bed methods. It was found that each has its merits . . . and its limitations. Proper selection depends on plant size, quality of charging stock, octane requirements and other factors.

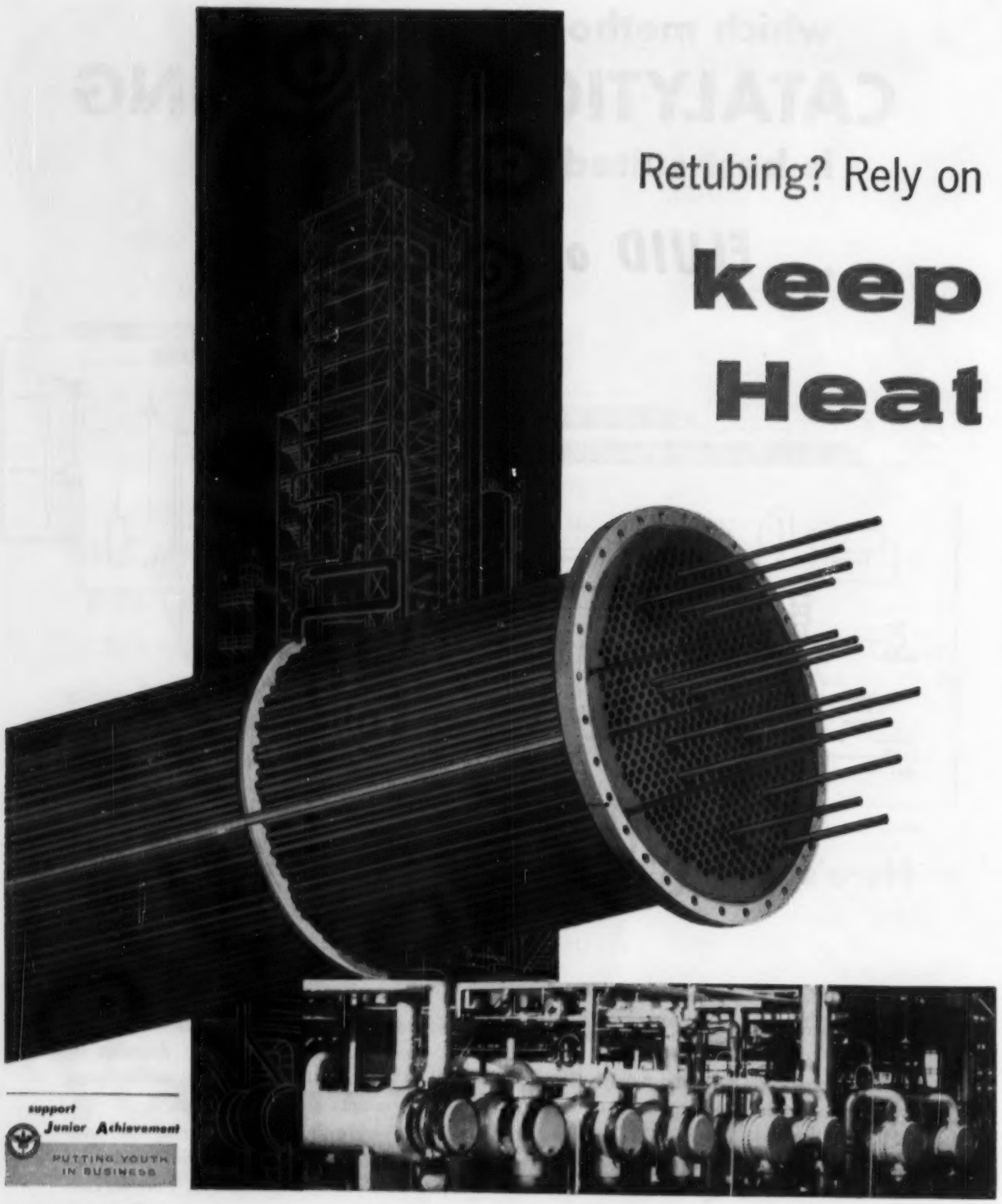
Our wide design, engineering and construction experience in both fluid and fixed bed catalytic reforming is at your service. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

For more data on advertised products, use Readers' Service Cards, last page.

Retubing? Rely on

keep Heat



support Junior Achievement
PUTTING YOUTH IN BUSINESS

First for Lasting Quality—from Mine to Market!

Phelps Dodge COPPER-BASE ALLOY Tubes to

your Exchangers On-Stream!

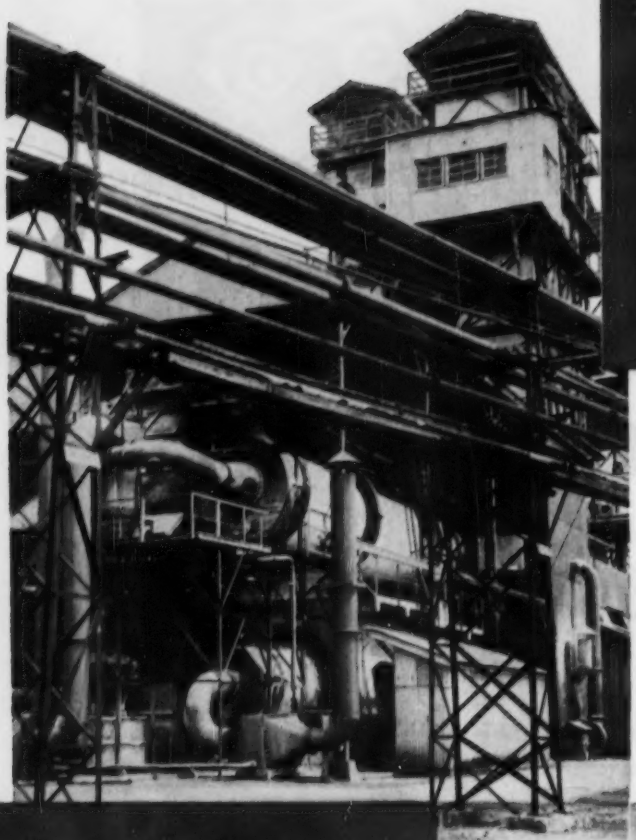
- **Complete line of copper-base alloys** including Bi-Metal combinations to meet special corrosive conditions.
- **Speedy delivery** from strategically-located warehouses.
- **Careful analysis of your corrosion problems** by experienced engineering staff.
- **Quality-controlled fabrication** to assure finest tube properties.
- **Information and sales service** available from nearest Phelps Dodge district office.*

PHELPS DODGE COPPER PRODUCTS CORPORATION

*SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle Washington, D. C.

95% ammonia efficiency

in the CHEMICO Urea Process



These Urea Prills made by the Chemico Urea Process for use as fertilizer contain 46% Nitrogen.

76% conversion of ammonium carbamate to urea

The Chemico Urea Process is employed in a 120 standard tons per day Urea Plant, shown in the photograph, which went into operation in the Fall of 1952 at Niihama, Japan, for the Sumitomo Chemical Company.

This same process is being used for a 90 short tons per day Urea Plant which Chemico is presently designing for Nihon Gas Kagaku Kogyo, Japan.

Chemico Urea Process operating records show an actual conversion of 76% in the presence of 200% excess ammonia. Theoretical maximum conversion when the stoichiometric feed ratio is used is only 48%.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

525 WEST 43RD STREET, NEW YORK 36, NEW YORK

Cable Address: Chemiconst, New York • Technical Representatives: Cyanamid Products Ltd, London

South African Cyanamid (Pty) Ltd., Johannesburg

Now WALWORTH *PVC* VALVES and FITTINGS

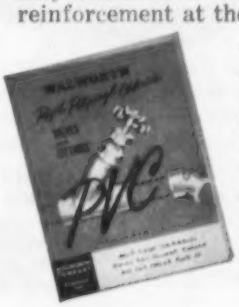
give you the greater protection and longer service of *all-plastic* piping systems!

The new Walworth plastic Valves and Fittings are made of rigid polyvinyl chloride which is non-aging, non-corrosive and non-toxic and has extremely low flammability and high resistance to chemical attack. Walworth PVC products are molded by General American Transportation Corporation. Each product bears the stamp of Walworth's long established engineering skill and reliability — your assurance of safe, trouble-free valves and pipe fittings.

Walworth PVC Y-Globe Valves are designed to regulate the flow of alkalis, acids, inorganic salt solutions and other troublesome fluids commonly found in food, chemical and allied industries. They will give exceptional service at temperatures as high as 150°F and are designed for use with schedule 80 pipe. Other features of these valves include: (1) Three chevron, Teflon packing rings give you a leak-proof seal without binding the stem. (2) No useless threads to accumulate troublesome dirt because no stem threads enter the interior of the body. (3) Snap-on spherical plug with ball-to-cone seating arrangement to assure a tight line-contact seal between disc and seat regardless of any minor inaccuracies in alignment. (4) Full 45° angle of stem with center line of pipe to reduce pressure drop and turbulence. (5) Generously designed flow passage at the valve seat for a more even flow. (6) Back seat design allows repacking when wide open under pressure. (7) Polyethylene bonnet gasket to assure a perfect body-to-bonnet seal.

Walworth PVC Diaphragm Valves come equipped with neoprene discs. Other diaphragms especially suited to your application can be furnished. "R-2" rubber diaphragms are commonly used in systems handling dilute acids and alkalis. "J-1" Teflon diaphragms are recommended for maximum chemical resistance. Valve design features: (1) No stuffing box or packing to replace. (2) A resilient diaphragm connected to the compressor by a stud assures a leakproof closure on the body weir or valve seat even when slurries or semi-solids are in the line. Diaphragm easily replaced without removing the valve from the line. (3) Streamlined flow area in valve body makes valve self cleaning and allows fluids to flow equally well in either direction. (4) Separation of valve body from the sealed metal bonnet protects fluids from contamination. Fluids contact only the valve body and diaphragm. (5) Completely enclosed metal bonnet protects stem from breakage and distortion.

Walworth PVC Fittings assure uniform thermal expansion of pipe and fitting threads when used on plastic pipe. They eliminate the danger of jammed threads, loose joints and the chance of galvanic corrosion. These screwed pipe fittings are: (1) Designed for use on schedule 80 of plastic pipe. (2) Walls are of uniform thickness accurately molded. Proportions are skillfully worked out in all sizes and types of fittings. (3) Fittings are chamfered to protect the thread and afford easy entrance of the pipe. Long bands provide reinforcement at the points of severest strain.



This booklet contains all the details about Walworth PVC products that you'll want to know. It describes mechanical and thermal properties, working pressures, sizes and dimensions, application and assembly data. For your free copy write to us. Please use company letterhead.

WALWORTH

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

WALWORTH COMPANY OF CANADA, LTD.
Toronto • Calgary

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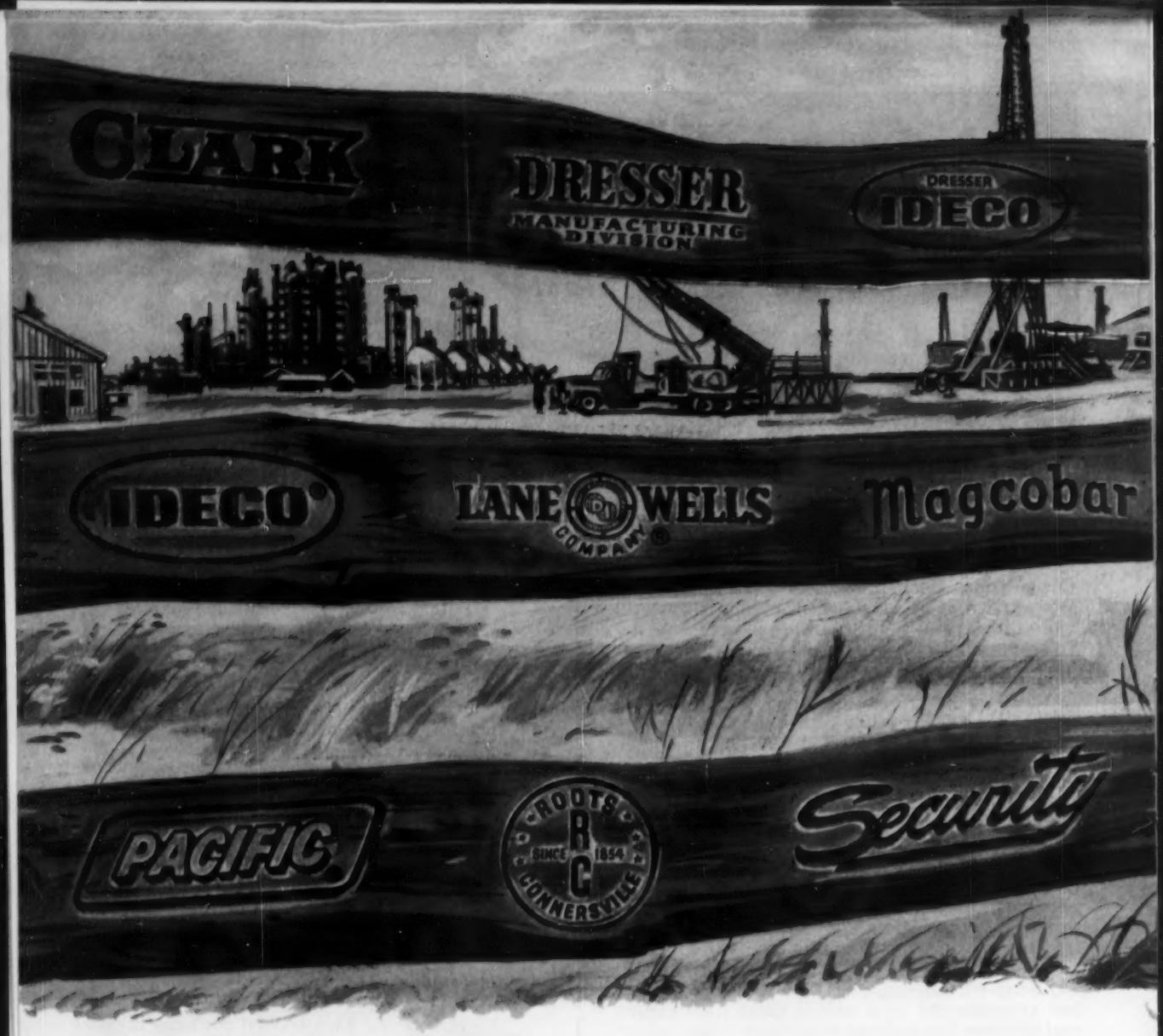
For more data on advertised products, use Readers' Service Cards, last page.



CLARK BROS. CO., Olean, New York — Gas turbines; engines; reciprocating, centrifugal, axial flow compressors—gas, steam, electric and diesel driven.

DRESSER MANUFACTURING DIVISION, Bradford, Pa.—Pipe line couplings, pipe repair sleeves and clamps, weldments and forgings, welding fittings, flanges, rings.

DRESSER-IDECO COMPANY Columbus, Ohio — Radio and television broadcasting towers, steel buildings, aircraft hangars, mechanical parking garages, electric power substations.

IDECO, Dallas, Tex. — Hydrair® and Power Rigs; Full-View® Masts; substructures; single, dual and Drive-In Rambler Rigs; blocks, swivels, rotaries; mud-pumps; petroleum equipment and supplies.

LANE-WELLS CO., Los Angeles, California, Houston, Tex., Oklahoma City, Okla.—Electric and Radioactivity Well Logging, Koneshot® perforating and bullet perforating, packers and bridging plugs.

MAGNET COVE BARIUM CORP., Houston, Tex.- Magcobar® and Magcogel® drilling muds and other specialized oil well drilling fluids and chemicals.

PACIFIC PUMPS, INC., Huntington Park, Calif.—Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. — Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

Every brand carries a bonus ... the Dresser Plus +

In Texas or Trinidad, in fact, wherever the oil, gas and chemical industries are flourishing, you'll find Dresser products and services put to good use. All are branded by the world-renowned trademarks of Dresser companies which operate individually the better to serve your specific needs. Yet each Dresser company's brand of dependability is fortified by a great plus factor common to all — the Dresser Plus +. It's a bonus in *extra* value . . . an intangible that's meaningless unless you've experienced it . . . but added strength, knowledge and resourcefulness when you call upon any Dresser company for any service. The inter-company teamwork of all nine Dresser companies assures the customer of any one the research, design, development and manufacturing services of all. *This* is the Dresser Plus + . . . from builders of oil, gas, chemical equipment and services that are the standard of comparison the world over.

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REPUBLIC NATIONAL BANK BUILDING

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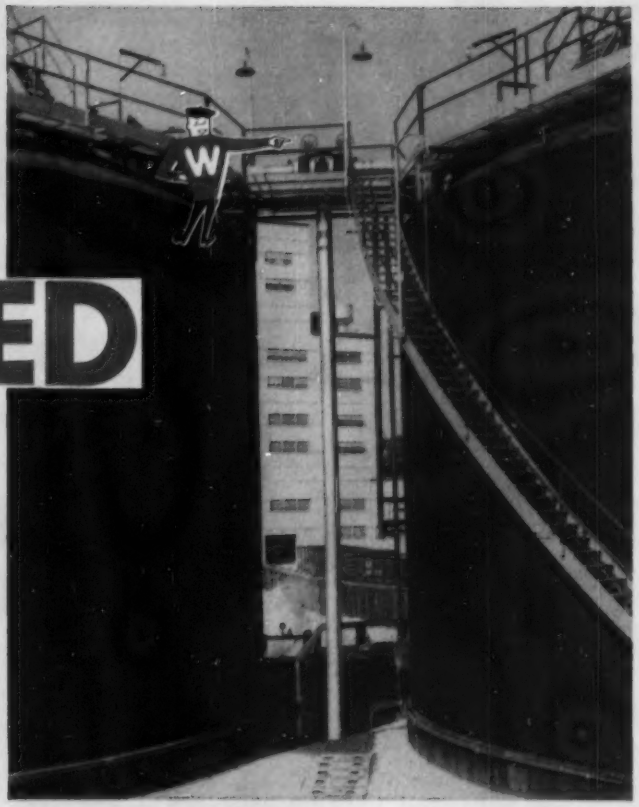
STEAM-JACKETED

for handling VISCOUS LIQUIDS



An installation of Wedgeplug Steam-Jacketed Valves in a large plant handling sulphur at a temperature of 270° F.

WEDGEPLUG
NON-LUBRICATED
STEEL PLUG VALVES

For Special Services—handling products that will harden or congeal at ordinary temperatures, such as: asphalt, pitch, petroleum residue, tar, resins, vegetable and animal fats, soap, sulphur, etc.—Wedgeplug Valves can be supplied Steam-Jacketed. Positive action of the valve is assured. Wrench-Operated or Gear-Operated; also can be furnished equipped for Remote Control.

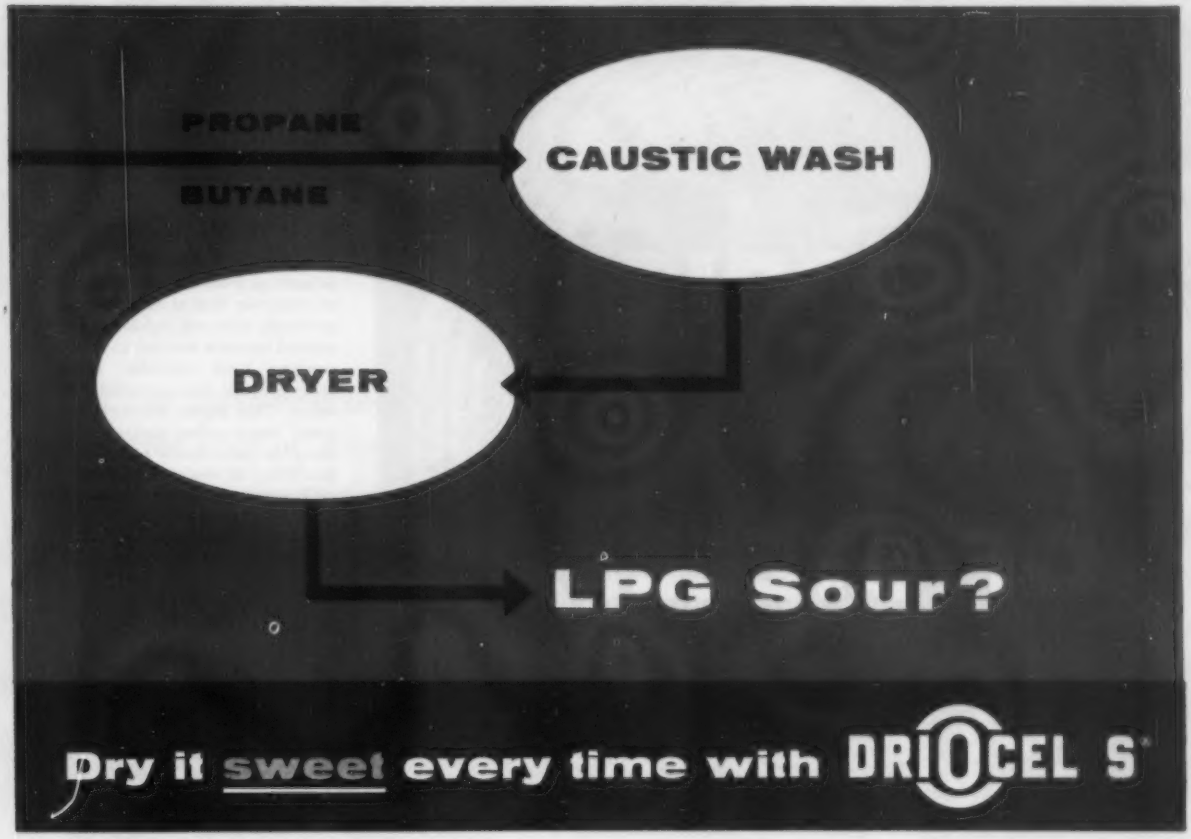
Write for Wedgeplug Catalog No. 55-1-W

WEDGEPLUG VALVE COMPANY, INC.
New Orleans 25, La.

An Affiliate of

STOCKHAM VALVES & FITTINGS
General Offices and Plant • Birmingham 2, Ala.

DESIGN ELIMINATES NEED FOR LUBRICATION



DRIOCEL S IS NEW. It is a low-cost, activated bauxite desiccant specifically developed to overcome souring of LPG products during the final drying step.

DRIOCEL S PERFORMS A THREE-WAY TASK.

1. It *does* a thorough job of drying the liquefied products.
2. It *does not* exhibit a souring reaction with sulfur compounds which originate in sour gases and crudes —escape the caustic wash—are entrained in the pre-dryer stream (which may deceptively test "sweet")—and then are decomposed in the dryer by ordinary desiccants to yield sour products.
3. Driocel S *does not* act as an acid polymerization catalyst toward heavy ends of the liquefied gases.

LONG SERVICE LIFE—Initial installations put on stream over two years ago are still operating.

THE SPECIFIC PROPERTIES of this new drying agent also suggest its use in the drying of chlorinated and fluorinated hydrocarbons.

Under the well-known brand name of Driocel, M & C offers a *complete* line of reliable desiccants for drying air, hydrogen, CO_2, hydrocarbon liquids and gases—further proof of our ability to solve many a tough processing problem with versatile sorptive minerals. The coupon will put us to work for you.

ATTAPULGUS **POROCEL PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
14 ESSEX TURNPIKE, MENLO PARK, N. J.

ALWAYS A BETTER WAY...

MINERALS & CHEMICALS CORPORATION OF AMERICA
14 Essex Turnpike, Menlo Park, N. J.

Please send me without obligation:

- ☐ Bulletin: "Bauxite As A Drying Agent"
- ☐ Generous sample of Driocel S

name_____ title_____

company_____

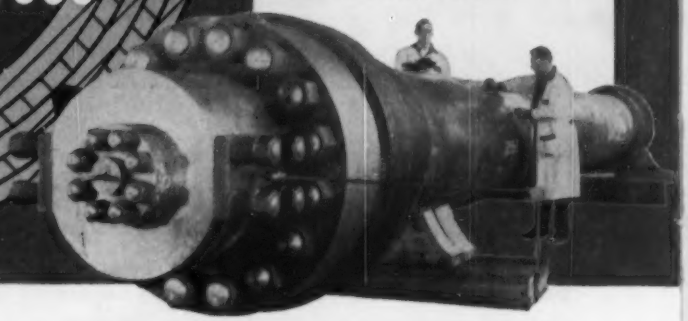
address_____

city_____ zone____ state_____

For more data on advertised products, use Readers' Service Cards, last page.

CYLINDRICAL SANDWICH OF STEEL...

A MULTI-LAYER PRESSURE VESSEL is built up from concentric layers of relatively thin steel plate progressively wrapped, tightened and welded together around an inner, pressure-tight cylinder. Inner layer is made like any solid wall vessel. This highly efficient, patented construction makes possible economies—*with safety and flexibility of design*—in heavy-wall vessels intended for use at extremely high pressures. United States Steel helped the manufacturer develop a special steel for these Multi-layer vessels.



saves money on heavy-wall, high-pressure vessels

With its ingenious Multi-layer pressure vessels, A. O. Smith Corporation opens up almost unlimited possibilities to the design engineer for commercial-size vessels for unusually high pressures—from 7500 to 30,000 psi. Instead of using hard-to-fabricate, heavy-gauge plates, A. O. Smith builds up the thick walls of these vessels with multiple layers of thin steel. As a result, welding conditions are improved and stress relief is not needed. Consequently, Multi-layer fabrication of heavy wall cylinders is more economical.

USS METALLURGICAL SERVICE HELPED SOLVE THE PROBLEM

When A. O. Smith engineers first conceived Multi-layer construction, process pressures were within limitations of standard A.S.T.M. steel strengths. However, as pressure demands increased, A. O. Smith needed a new and very special steel. And that is where United States Steel came to their aid. We helped them develop a high-tensile, high-yield strength, low-alloy plate steel with a minimum ultimate strength of 105,000 psi., a minimum yield strength of 70,000 psi., and good weldability.

HELP FOR YOU

When you have any sort of steel problem, let USS metallurgists help you with it—whether you need a special steel or just want to be sure you have the *very best* of the standard AISI analyses for your job. Phone our nearest district sales office. Or write United States Steel, Room 4990, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

See The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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S-2213

ELECTRIC FURNACE OR OPEN HEARTH

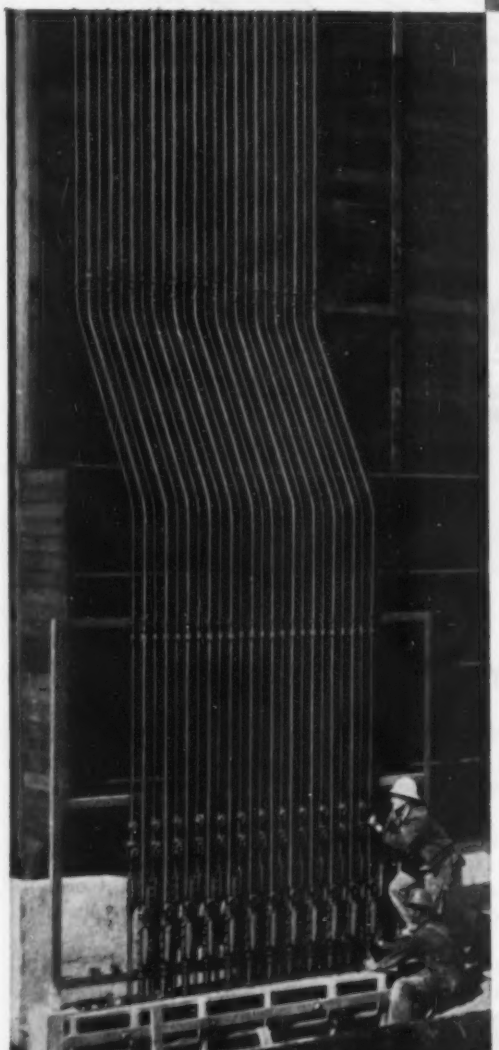
COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

UNITED STATES STEEL

DOWN a humid 180 feet below water level at Downsville Dam

UP in the corrosive air at a water cooling tower

Some 3600 feet of 2" Everdur Conduit (E.M.T.) protect electric lines in a service shaft plunging down to the release water chamber 180 feet below water level at Downsville Dam of the New York Metropolitan Water Supply System. Electric lines operate vital valves, indicating and communication equipment.



During the War, General Petroleum Corp. saw galvanized conduit fail within a year at one of its plants—replaced it with Everdur Conduit. At its new Ferndale Mobilgas Refinery in Washington, some 12,000 pounds of Everdur Conduit in various sizes guard electric power lines for motors and lighting in this water cooling tower.

EVERDUR Conduit will guard the electric power lines—for years

Everdur* Never Rusts. It offers high resistance to other types of corrosion. That's why Everdur Conduit—made from one of Anaconda's exclusive copper-silicon alloys—is specified for dependable year-after-year protection of electric power lines in industry, on bridges, at power and water supply projects—wherever water and corrosive atmospheres are a problem—or where conduit must be buried or embedded in concrete.

Everdur is Tough. In addition to corrosion resistance, Everdur has high physical strength, resists wear and abrasion. It stands up under movement and vibration, as on a bridge, in a subway, in a factory.

Everdur is Nonmagnetic. Everdur Conduit creates no magnetic field to produce temperature rise in electric power cables.

Everdur Electrical Conduit is available in two wall thicknesses —R.C. in nominal sizes from ¼" to 4", inclusive, and E.M.T. in nominal sizes ⅜" to 2", inclusive. For more detailed information write: The American Brass Company, Buffalo Division, Buffalo 5, N. Y. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

*Reg. U. S. Pat. Off.

EVERDUR ELECTRICAL CONDUIT

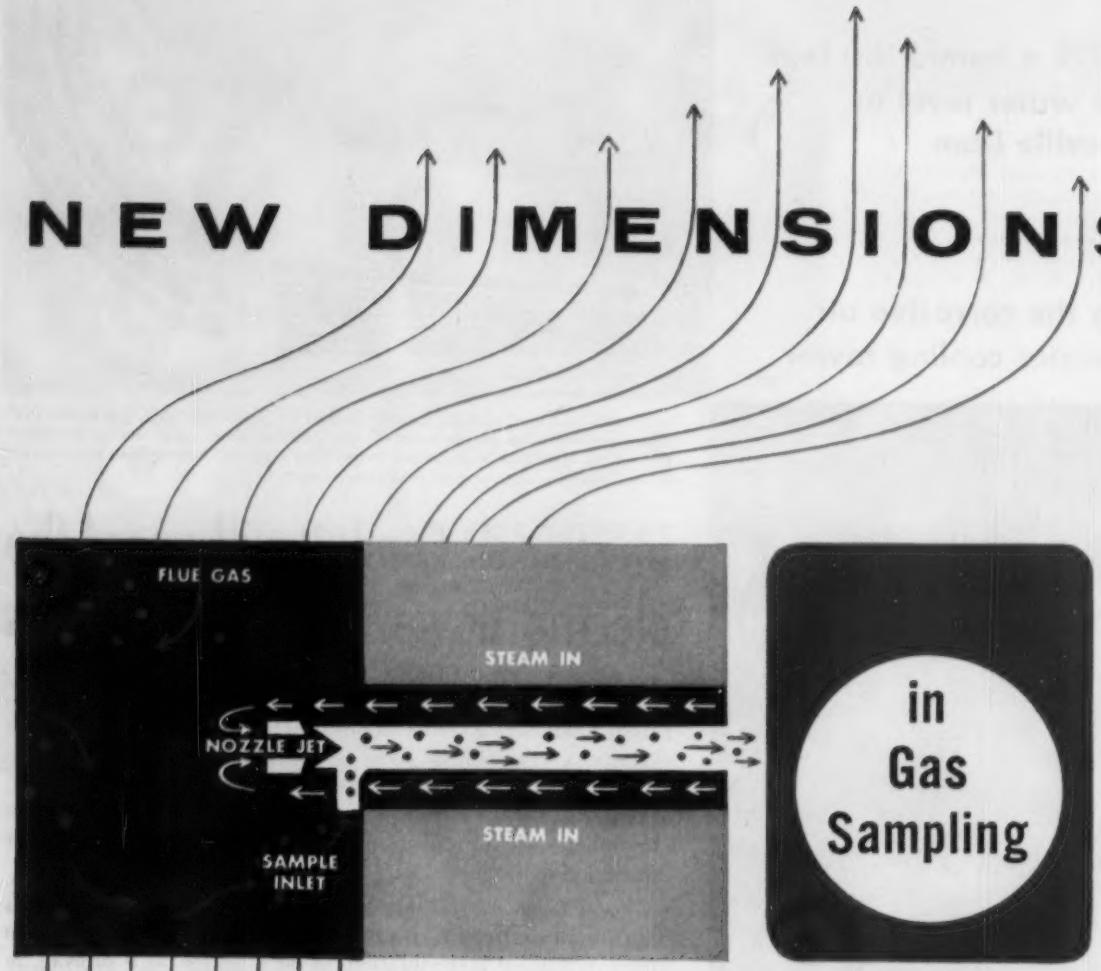
ANACONDA®

COPPER SILICON ALLOYS

CORROSION RESISTANT • STRONG • NONMAGNETIC • WORKABLE • WELDABLE

For more data on advertised products, use Readers' Service Cards, last page.

NEW DIMENSIONS



in Gas Sampling

NEW SAMPLING SYSTEM OPERATES ON STEAM!

The new Hays Gaspirator* System is designed especially for difficult gas sampling problems involving high dust loading and high temperatures. It now permits accurate O_2 measurement, previously impossible in many applications.

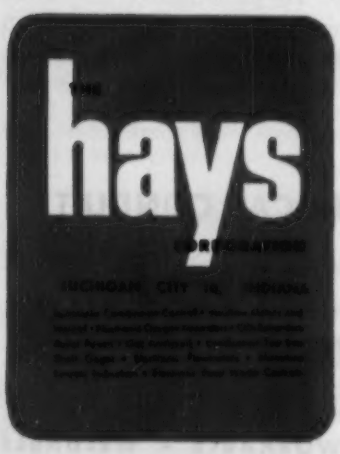
This gas sampling system uses steam to obtain a continuous, clean sample. Suction which is created by the jet nozzle draws the sample in, where it is mixed with the steam. The steam is then condensed. Condensate and entrained solids drop down, and the sample is forced through the analyzer under pressure.

Hays, in the field of gas analysis for more than fifty years, developed the Gaspirator for use with their Magno-Therm Analyzer.

This analyzer, which operates on the paramagnetic principle, has for years been accepted as the leader in the field of O_2 measurement. Hundreds of companies are using the Magno-Therm and Hays electronic recorders very successfully in boiler plants and on process furnaces as a combustion guide, in regeneration of catalysts in refineries and in many other process applications.

For further details write for Bulletin 55-829-56.

*Patents pending.

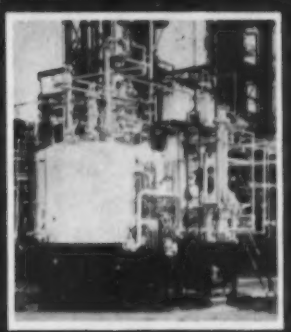
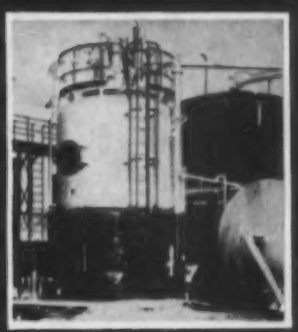
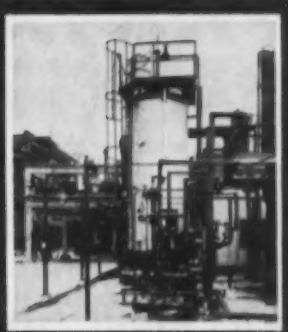
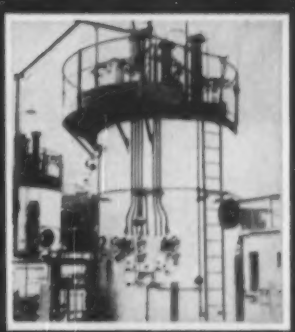


BECAUSE OF THESE ADVANTAGES

more and more refiners are specifying

PETRECO
ELECTRIC DISTILLATE TREATING

- Single vessel, one pass operation
- Automatic control
- Continuous process
- Intensive contacting
- Closed system, no fumes
- Minimum caustic and/or acid usage
- Low entrainment loss
- Minimum operating attention
- Small space requirement
- Purchase or rental option
- Always available service

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- Acid contacting
- Water washing
- Doctor treating
- Nitrogen base removal
- Jet fuel treating
- Cat cycle treating
- Furnace oil improvement

Specialized Electric Petroleum Processing

DEHYDRATING • DESALTING • LUBE OIL TREATING

DISTILLATE TREATING • SEDIMENT SEPARATION

DESAPONIFICATION

DT-4

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A DIVISION OF PETROLITE CORPORATION

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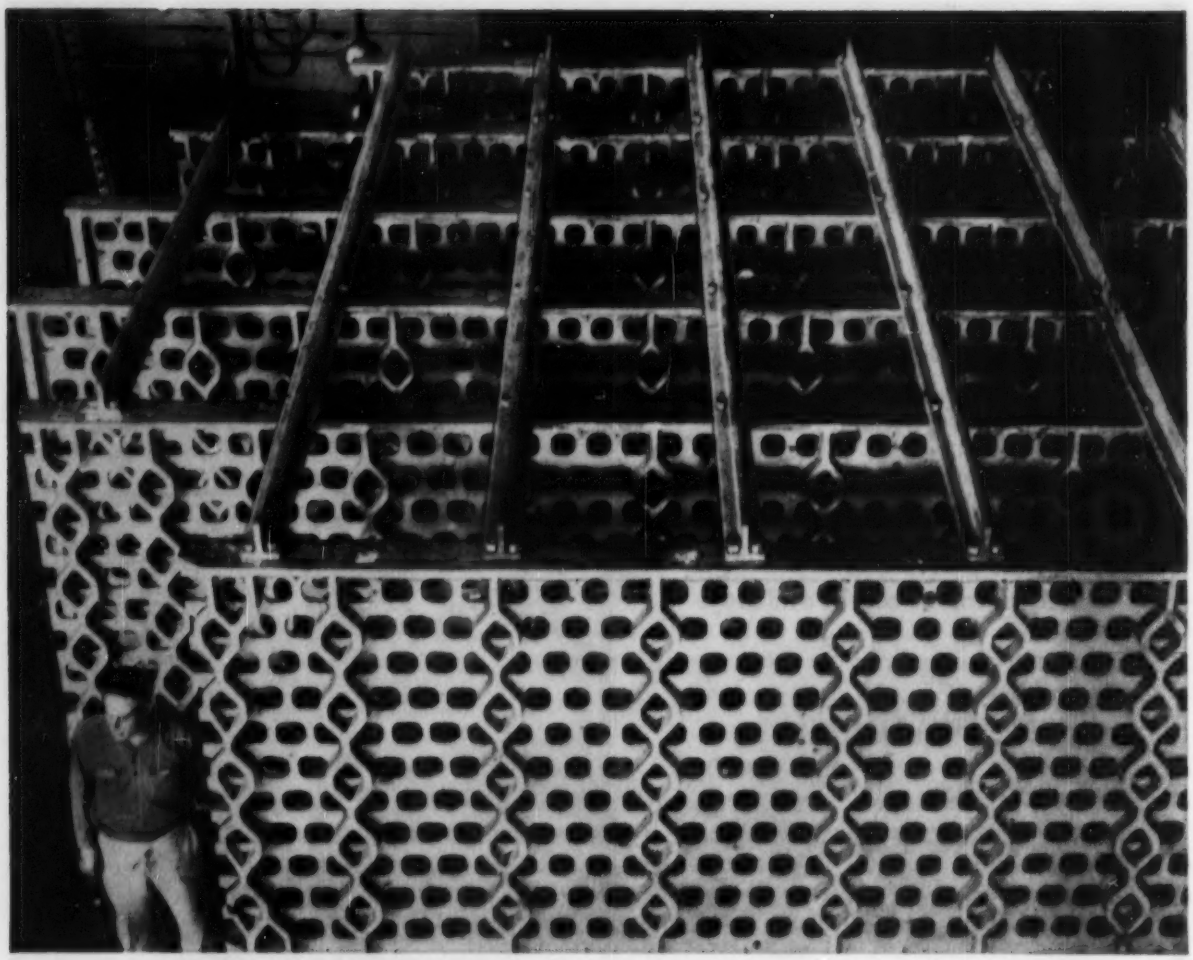
1390 East Burnett Street, Long Beach 6, California

For more data on advertised products, use Readers' Service Cards, last page.



Heat-resisting stainless alloy containing 25% chromium and 12% nickel makes possible cast tube supports that meet two basic demands: (1) high resistance to creep, (2) resistance to oxidation at temperatures upward of 1300°F. These type "HH" tube supports for a petroleum refinery were cast by Duraloy Company, Scottsdale, Pa., and assembled by welding. Total weight: 55,000 lbs.

Chromium-Nickel alloy tube supports carry load... resist creep and corrosion above 1300°F

THE HIGH-TEMPERATURE STRENGTH of these cast stainless tube supports permits years of use under normal operating conditions.

Even under abnormal conditions, such as a fire, these stainless castings provide adequate strength over a time period that usually allows regaining control.

Key to their load-carrying ability . . . and to their oxidation-resistance at high temperature . . . is a combination of 25% chromium and 12% nickel.

Cast heat-resistant nickel alloys of this type show more than satisfactory resistance to oxygen-sulphur compounds, chiefly sulphur dioxide, and to other agents that attack tube supports in fired coils.

Nickel alloyed irons and steels prove their dependability in all sorts of refinery applications. Whenever you face a problem where you need greater strength, or resistance to corrosion or abrasion at normal, high or low temperatures, let's talk it over. We may be able to help you dispose of a troublesome difficulty.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

Struthers Wells

FIRED HEATERS

BUILT IN STANDARD SIZES

from 500,000 to 40,000,000 B.T.U. per hr.

for

DIRECT HEATING...

- *Petroleum Oil*
- *Hydrocarbon Gases*
- *Asphalt*
- *Air*
- *Oxygen*
- *Hydrogen*
- *Superheating Steam*

and for

INDIRECT HEATING...

- *Using indirect heat transfer mediums, including molten metal, molten salt, Dowtherm, mineral oil and other fluids*

The rich-oil heater illustrated is installed in a gas processing plant in Oklahoma, having a capacity of approximately 60,000,000 standard cubic feet per day. A special coil installed in the heater is used to superheat the steam from oil-field-type boilers installed nearby.

This heater is typical of hundreds of similar units installed in gasoline plants, petroleum refineries, chemical plants and for a wide range of services. Equipment is in service to the highest commercial temperatures.

Struthers Wells

STRUTHERS WELLS CORPORATION

WARREN, PA.

PLANTS AT WARREN, PA. AND TITUSVILLE, PA.

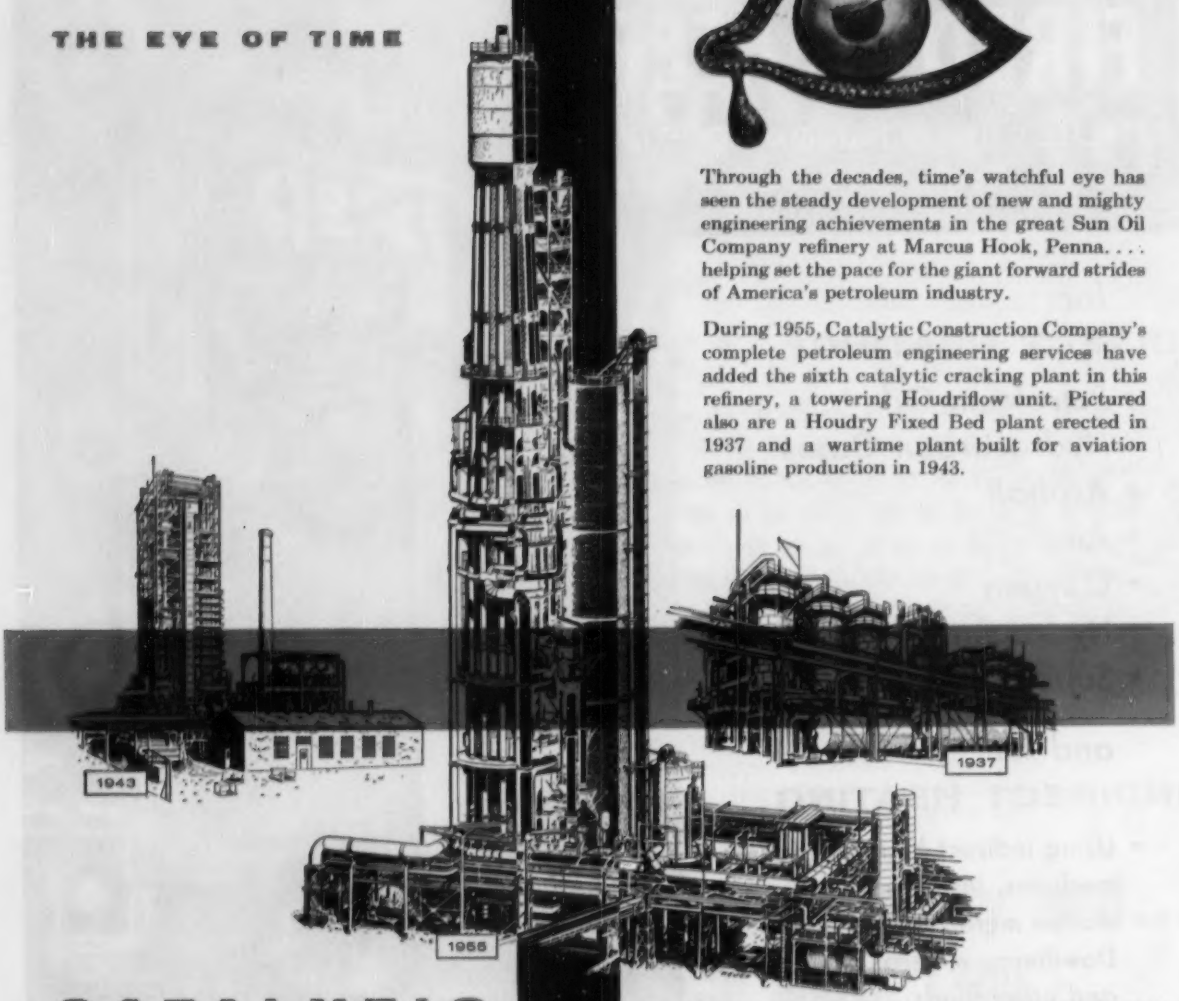
Offices in Principal Cities

THE EYE OF TIME

"THE EYE OF TIME"
jeweled timepiece by Salvador Dali,
shown by permission of
The Cotherwood Foundation,
Bryn Mawr, Penna.

Through the decades, time's watchful eye has seen the steady development of new and mighty engineering achievements in the great Sun Oil Company refinery at Marcus Hook, Penna. . . . helping set the pace for the giant forward strides of America's petroleum industry.

During 1955, Catalytic Construction Company's complete petroleum engineering services have added the sixth catalytic cracking plant in this refinery, a towering Houdriflow unit. Pictured also are a Houdry Fixed Bed plant erected in 1937 and a wartime plant built for aviation gasoline production in 1943.



CATALYTIC construction company

1528 Walnut Street

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CATALYTIC CONSTRUCTION OF CANADA, Limited; Sarnia, Ontario

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We at Maintenance Engineering do our best to make your Christmas tree ever green, every day; to keep your Christmas rolling all year long. We look to our principals for reliable products; we want you to depend on us for reliable service. But right now, first and foremost, we ALL wish you a . . . . .

MERRY CHRISTMAS!

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Engineering CORPORATION
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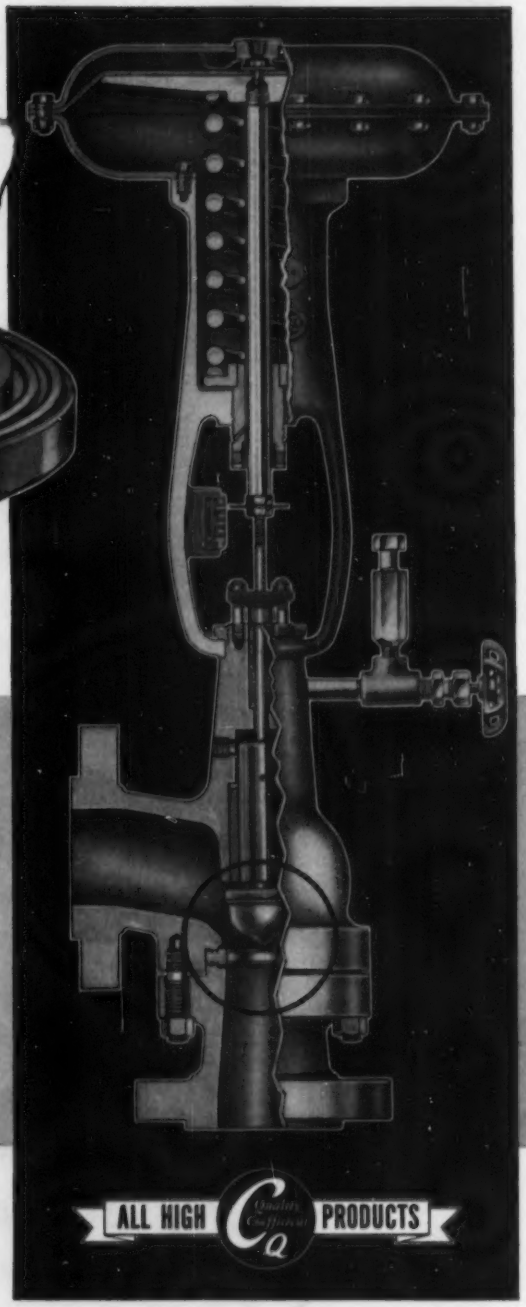
"These Exclusive Better Service,



SPECIFICATIONS:

777 SERIES CONTROL VALVE

Material:	Cast steel or cast iron
Size:	1" to 6"
Connections:	Flanged
Rating:	Cast steel — ASA 150, 300, 400, 600 lb. Cast iron — ASA class 125, 250

Available with direct motor (No. 777-19) or reverse motor (No. 778-19) and with finned bonnet construction.

PLUS values . . .

Design Features Insure Greater Flexibility"

Here are the three big reasons you get more for your money with Masoneilan angle valves . . .

REVERSIBLE SEAT RING has ground and lapped gasketless joint assuring accurate centering, vertical alignment and tightness. Provides new seating surface quickly when needed, shortens downtime.

REDUCED CAPACITY plugs and seat rings available in .4 Factor standard reduction. Also in .7 Factor for added flexibility in 6" valves used in high pressure-drop service; and in $.4^2$ Factor (capacity ratio .16); and in $.4^3$ Factor (capacity ratio .06) for use on small flow applications.

PLUG GUIDING IS HEAVY DUTY, large diameter guide section with minimum length of two guide diameters operating in hardened stainless steel bushing.

Masoneilan 777 series Control Valves are well suited for slurry service, in heater drainer service where flashing may occur, and on soot blower applications. Their streamlined, non-clogging inner contours cut down erosion and reduce turbulence.

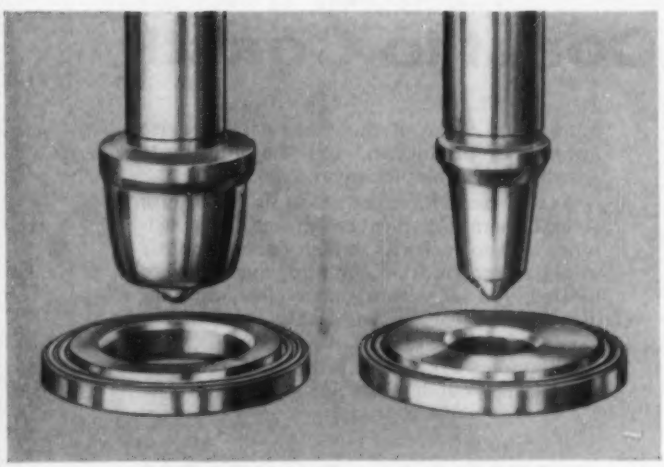
It will pay you to get the story on *all* Masoneilan Control Valve *plus* features. They add up to extra value and true cost reduction. Call your nearest Mason-Neilan representative or write:

MASONEILAN

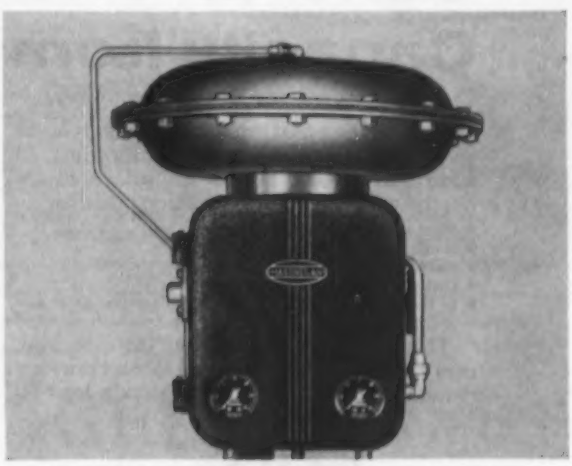
MASON-NEILAN REGULATOR CO.

1182 ADAMS STREET, BOSTON 24, MASS., U. S. A.

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco • Boise • Louisville • Salt Lake City El Paso • Albuquerque • Odessa • Charlotte • Los Angeles • Corpus Christi • Denver • Appleton • Birmingham New Orleans • Dallas • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

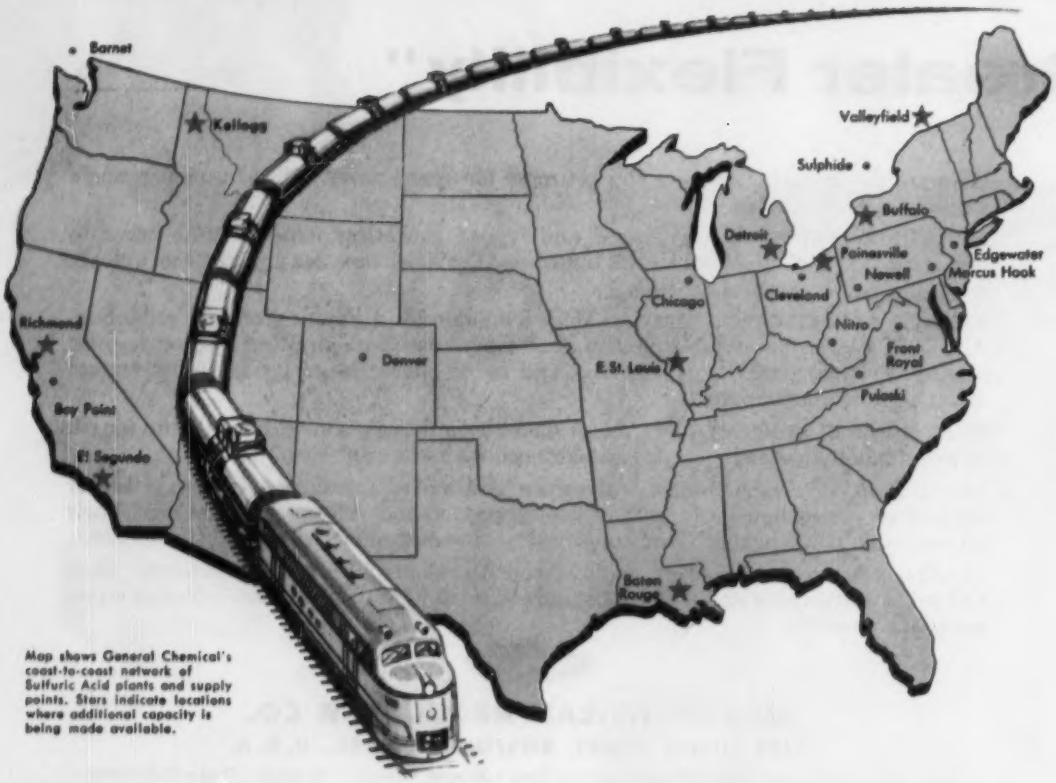


Full capacity and .4 Factor plugs and seat rings are interchangeable in standard body, as are other reduced capacity plugs and seat rings. They are all precisely sized for accurate fit and alignment.



New 2800 series (Model 2807 shown) Pressure Controllers offer (1) fast response, (2) high sensitivity, (3) low cost and (4) proportional band of 1 to 30%.

An 80-Mile Train of New Sulfuric Acid Production!



Map shows General Chemical's coast-to-coast network of Sulfuric Acid plants and supply points. Stars indicate locations where additional capacity is being made available.

General Chemical Expands Capacity from Coast to Coast!

In an expansion that extends to all points of the compass, General Chemical is providing an additional 600,000 tons of Sulfuric Acid annually, with increased production facilities . . .

- ★ West at El Segundo and Richmond, Calif.
- ★ South at Baton Rouge, La.
- ★ North at Valleyfield, Que.*
- ★ East at Buffalo, New York
- ★ In the Mid-west at Detroit, Mich., Painesville, Ohio and E. St. Louis, Ill.

This means approximately 12,000 more tank cars of Sulfuric Acid available to meet growing requirements of industry . . . a train load 80 miles long! Some of these new facilities are already in production, and the others are scheduled for completion in 1956.

As America's foremost producer of Sulfuric Acid, General Chemical recognizes a responsibility to keep pace with industry's need for this vital basic chemical. No matter where you are located, you are within a short, low-cost haul of a primary producing center of General Chemical Sulfuric Acid. Remember . . . in emergencies and at all times . . . General Chemical is your dependable source of Sulfuric.

Basic Chemicals for American Industry

Allied Chemical

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
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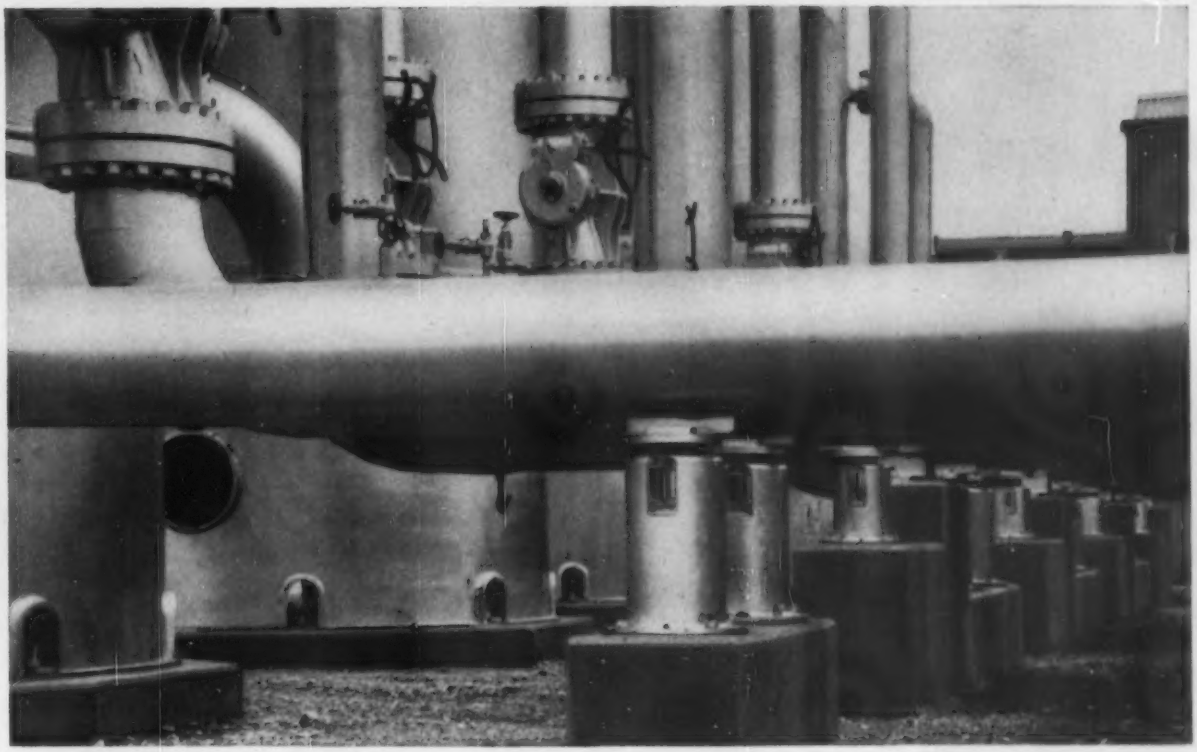
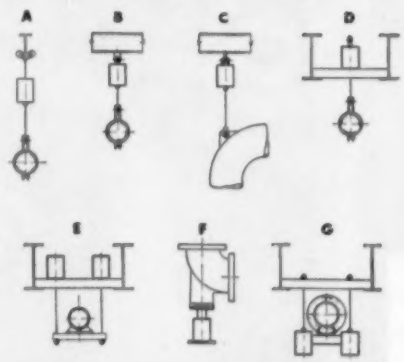
In Wisconsin: General Chemical Company, Inc., Milwaukee
*In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver



For *flexible* support of piping

Grinnell Pre-Engineered Spring Hangers

AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS



(Type A) Rod threaded to top cap (Type B) Furnished with single lug (Type C) Two lug style (Type D) Top adjusting (Type E) Adjustable top and bottom (Type F) For base support (Type G) Trapeze assembly.

The Grinnell Pre-Engineered Spring Hanger was developed after years of experience in analyzing the problems of flexible pipe suspension systems. It is *pre-engineered* to minimize changes in supporting force over total range of movement. Consider these outstanding features:

- **Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.**
- **Precompression* assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.**
- **Solid steel casing protects spring from damage and weather. Guides assure continuous alignment and concentric loading of spring.**
- **18 sizes available from stock for load ranges from 53 lbs. to 12,000 lbs.**
- **Available in 3 spring lengths for travel ranges of 1¼, 2½, and 5 inches.**
- **Installation is simplified by integral load scale and travel indicators.**

***Precompression is a patented feature.**

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

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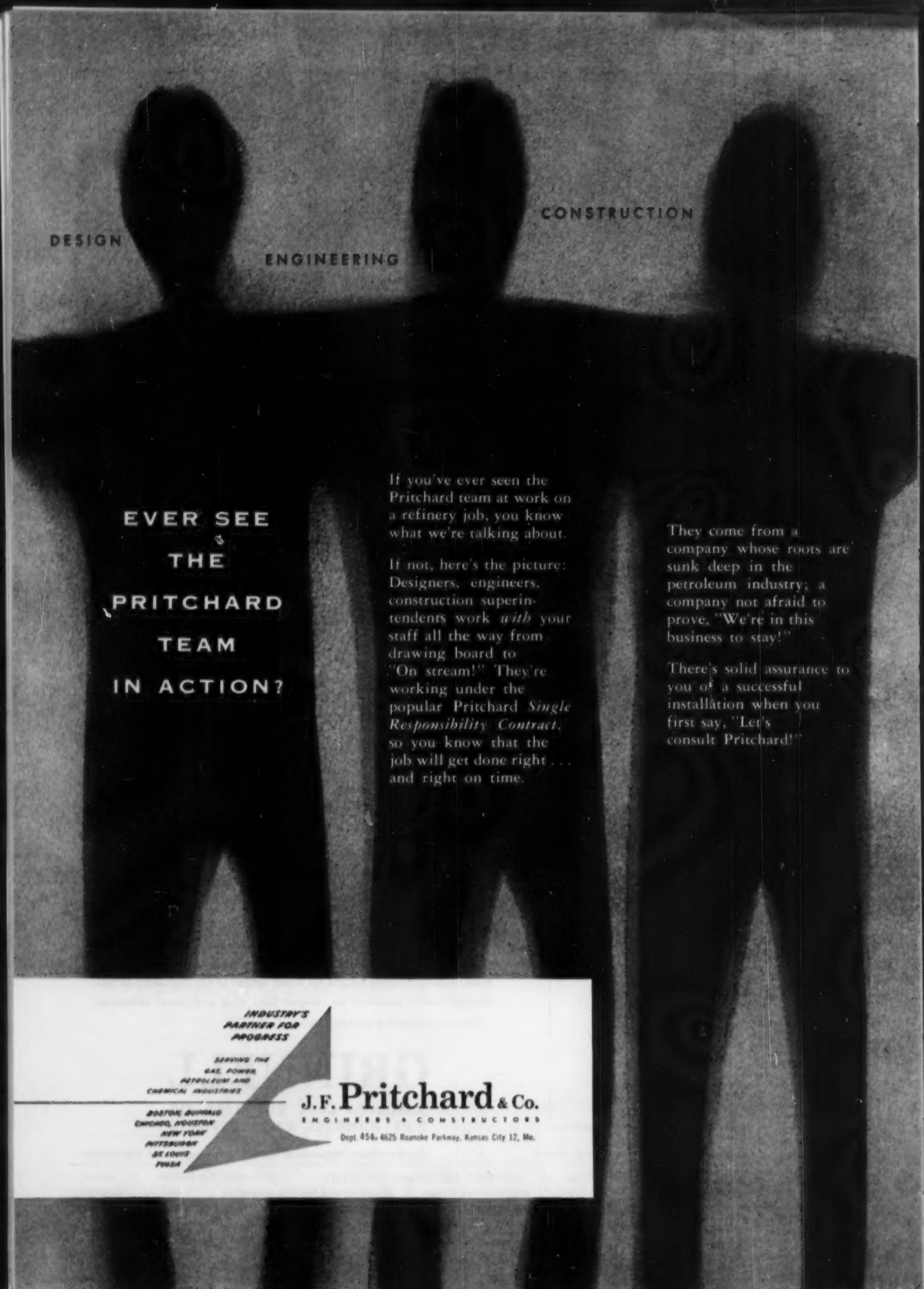
For more data on advertised products, use Readers' Service Cards, last page.



EVER SEE THE PRITCHARD TEAM IN ACTION?

If you've ever seen the Pritchard team at work on a refinery job, you know what we're talking about.

If not, here's the picture: Designers, engineers, construction superintendents work *with* your staff all the way from drawing board to "On stream!" They're working under the popular Pritchard *Single Responsibility Contract*, so you know that the job will get done right . . . and right on time.

They come from a company whose roots are sunk deep in the petroleum industry; a company not afraid to prove, "We're in this business to stay!"

There's solid assurance to you of a successful installation when you first say, "Let's consult Pritchard!"

INDUSTRY'S PARTNER FOR PROGRESS

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

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J.F. Pritchard & Co.

ENGINEERS • CONSTRUCTORS

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Dependable

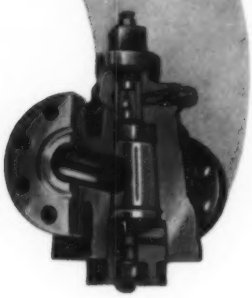
Rockwell-Nordstrom, *the* quality valve, is the most dependable valve you can use because it's *pressure lubricated*. Whether it is operated once a year or once every hour, the unique pressure lubrication system is always at work eliminating metal-to-metal friction, providing a leak-proof seal, and cushioning the plug for easy operation.

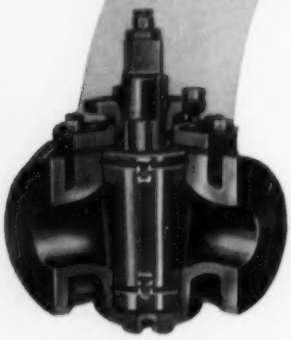
Rockwell-Nordstrom valves and plug valve lubricants are an investment you can always depend on for dividends in trouble-free service. Why not follow the leaders who have used Rockwell-Nordstrom valves for forty years? Rockwell Manufacturing Company, Pittsburgh 8, Pa.

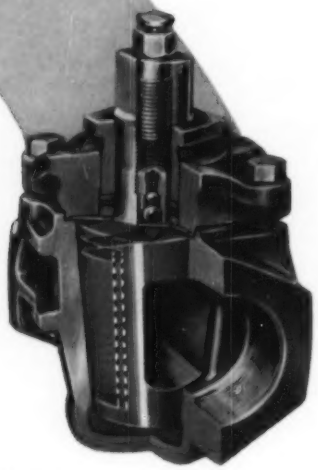
ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

GASES







Lubricant Sealing Holds Even the Lightest Gases

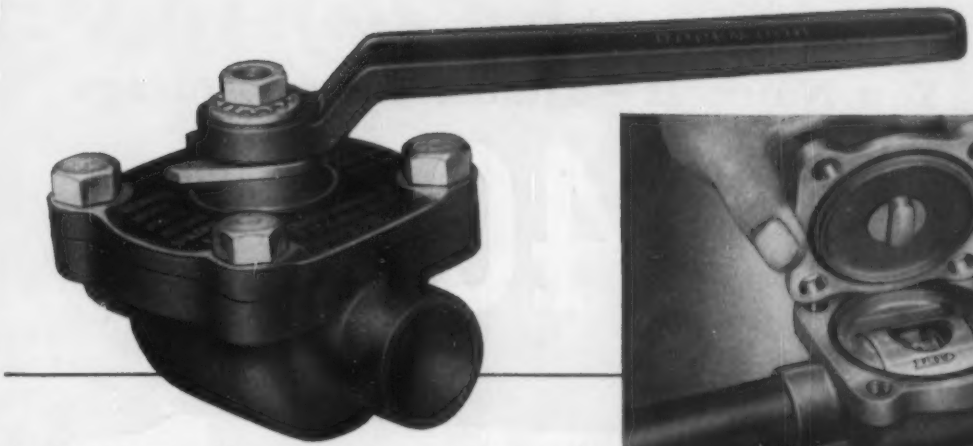
Rockwell-Nordstrom valves are the most efficient valves for any gas service because they're *lubricant sealed.* The unique Sealdport* grooves in the plug and body carry pressurized lubricant which forms a truly leak proof seal for the lightest hydrocarbons. Ordinary valves depend solely upon risky metal-to-metal closure where one tiny scratch means a leak.

Whatever your gas control problems, there is the perfect combination of Rockwell-Nordstrom valve and lubricant to do the job more dependably and economically than any other valve you've ever used. Write on your letterhead today for full details. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

*a registered trademark of Rockwell Manufacturing Company

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF



FAST, LOW-COST CHANGE IN DIRECTION OF FLOW. Removal of the body cap permits reversing the cage assembly to allow change in direction of flow. In addition, this feature lets you change seat material, and clean the valves thoroughly and quickly — *without removing the valve from the line!*

INTERCHANGEABILITY of seat material to meet your operating requirements is another feature of the Rockwood Top Entry Ball Valve. Seat can be furnished in Buna-N, Neoprene, Kel-F, Teflon, and Nylon.

EASY INSTALLATION AND OPERATION is permitted because of the new handle design. This new design allows the handle to be placed in any of *eight positions!*

Now!... New Rockwood Top Entry Ball Valve

. . . A new concept in valves that saves you money and time!

Made of bronze the new Rockwood Top Entry Ball Valve is ideal for handling oxygen and hazardous liquids as well as water, oil and gas. It carries 300 lbs. per square inch on water, oil and gas and 400 lbs. per square inch on LP gas and is available both with sweat ends and screw ends, in sizes ½", ¾" and 1".

Write for complete data on this unique full round pipe size flow.

ROCKWOOD BALL VALVES

Distributors in all Principal Industrial Areas

ROCKWOOD

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Please send me complete information on Rockwood Top Entry Ball Valves.

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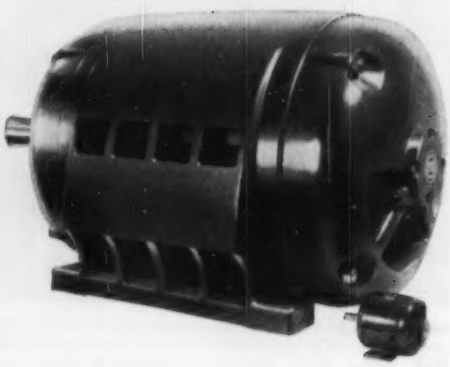
You Name It—Thousands of Ratings

From 1/8 to 400 H. P.

See MASTER for a selection of motor drives that you can get nowhere else—for specialized power drives unequalled for flexibility, compactness and performance. See Master for the right horsepower, right shaft speed, right mounting features—to add salability to your products, efficiency to your plant equipment.

Master components are designed to combine in one compact unit to suit your needs exactly—all the way up to 400 H. P. Just ask us for information.

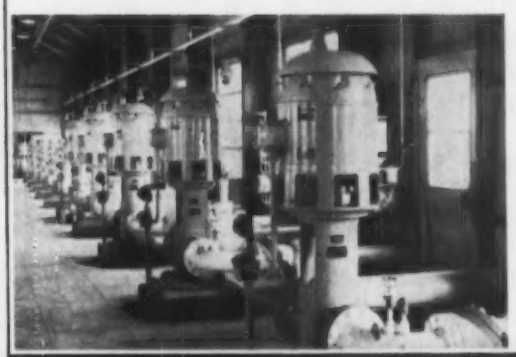


Motor Ratings	⅛ to 400 H.P. All phases, voltages, and frequencies.
Motor Types	Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.
Construction	Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.
Speeds	Single-speed, multi-speed, and variable speed.
Installation	Horizontal or vertical, with or without flanges and other features.
Power Drive Features	Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

THE MASTER ELECTRIC COMPANY
Dayton 1, Ohio

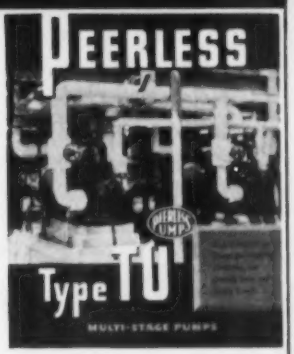
MASTER ELECTRIC MOTORS

either way YOU LOOK AT THE PUMPING PROBLEM



Vertical

Horizontal



PERFORMANCE-PROVED PEERLESS PUMPS WILL DO THE JOB BETTER

Here's why—You can choose from either Peerless vertical or Peerless horizontal designs for most every liquid transfer job—water or process liquids. You can select the pump you need from the broadest range of heads, capacities and horsepowers.

You can buy and apply a Peerless pump with the confidence that it will provide dependability over the years.

Bulletin B-1700, at the top above, describes Peerless vertical can type process pumps. Bulletin B-1400 just above describes multi-stage horizontal pumps for high pressure liquid transfer.

Write for your copies. You'll find out how Peerless pumps can squarely meet your pumping needs with economy, efficiency and dependability.

PEERLESS PUMPS

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FOOD MACHINERY AND CHEMICAL CORPORATION
Factories: Los Angeles 31, Calif., and Indianapolis 8, Ind.
Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis, Ind.; Phoenix; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque, New Mexico.
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PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26, Los Angeles 31, California

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☐ PEERLESS MULTI-STAGE HORIZONTAL PUMPS (B-1400)

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COMPANY_____

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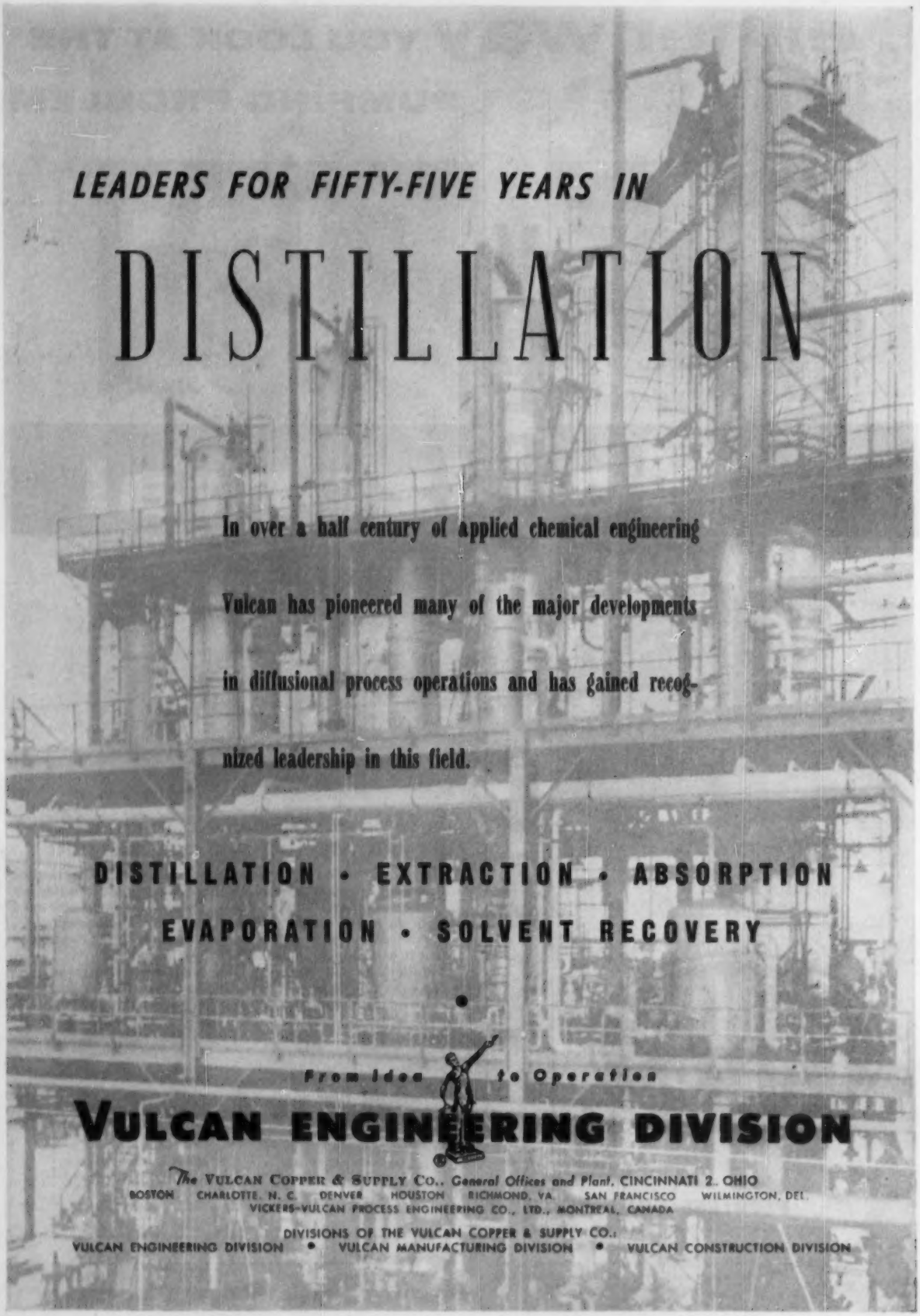
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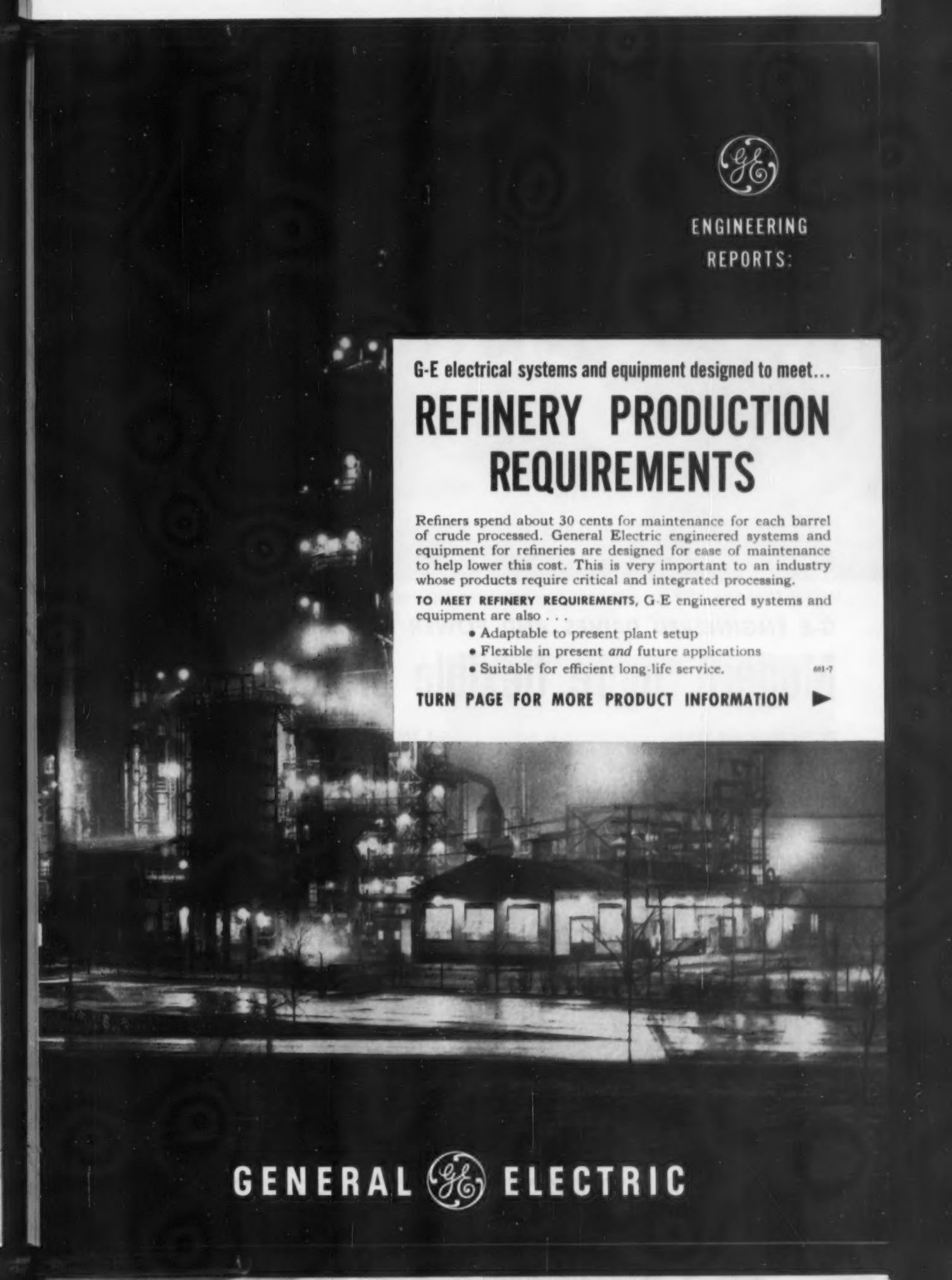
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G-E electrical systems and equipment designed to meet...
REFINERY PRODUCTION REQUIREMENTS
Refiners spend about 30 cents for maintenance for each barrel of crude processed. General Electric engineered systems and equipment for refineries are designed for ease of maintenance to help lower this cost. This is very important to an industry whose products require critical and integrated processing.
TO MEET REFINERY REQUIREMENTS, G-E engineered systems and equipment are also . . .
• Adaptable to present plant setup
• Flexible in present and future applications
• Suitable for efficient long-life service.
681-7
TURN PAGE FOR MORE PRODUCT INFORMATION
GENERAL ELECTRIC

SEVERAL AVAILABLE TYPES of protective enclosures make G-E motors ideal for all indoor or outdoor uses. New Polyex insulation

G-E ENGINEERED DRIVES AND POWER SYSTEMS MEAN . . .

Modern, more flexible processing lines

IN THE NEXT TEN YEARS, production must increase an estimated 50% to meet greater consumer needs. Available manpower will increase only an estimated 14% during the same period.

INCREASED OUTPUT AND EFFICIENCY must close the production gap between available manpower and estimated demand. General Electric electrical systems are designed and installed for efficient, flexible, easily expanded production.

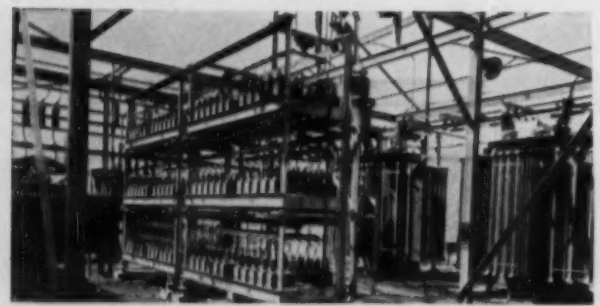
G-E ENGINEERING SERVICES (see back page) can help you meet production requirements to bring your electrical system up to date. The result is a modern system integrated into your present plant setup.

FOR ADDITIONAL INFORMATION on how G-E engineered systems and engineering services can help you, contact your G-E Apparatus Sales Representative during your early planning at the nearest G-E Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y.

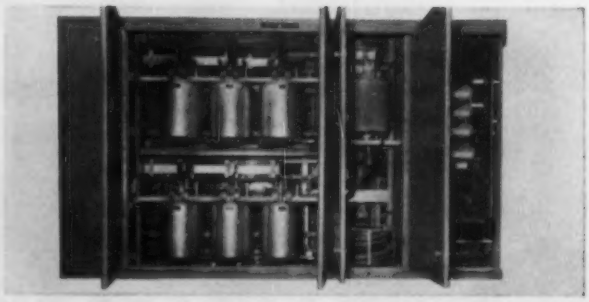
681-5

Engineered Electrical Systems for Process Industries

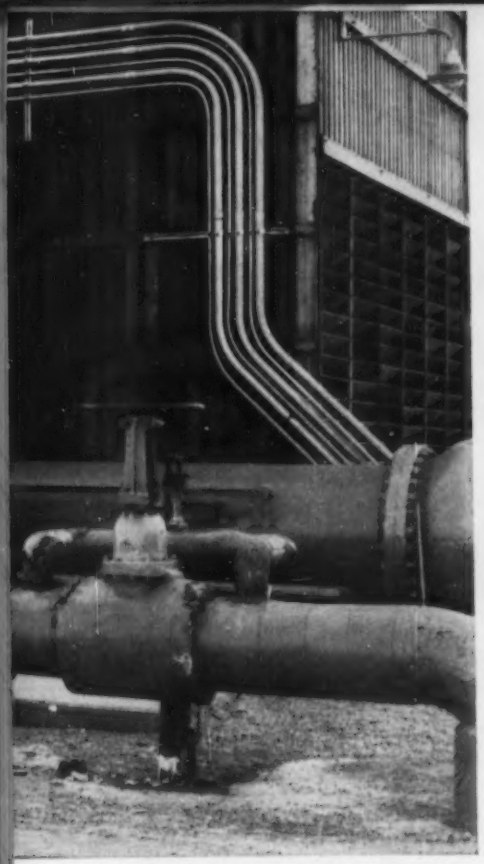
GENERAL ELECTRIC



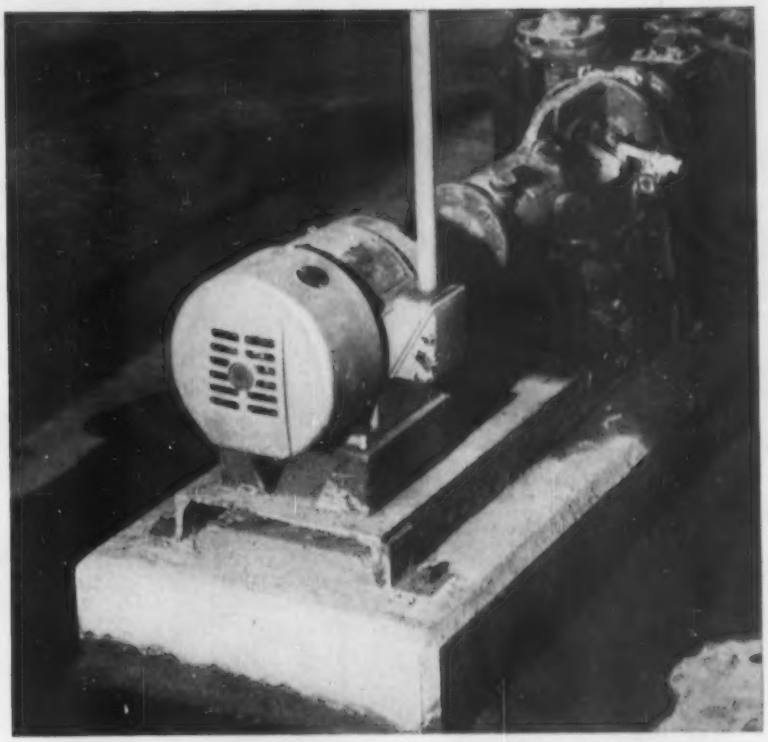
"BUILDING-BLOCK" design of this stack-rack capacitor block reduces installation costs. This design means equipment may easily be expanded or moved to meet plant requirements.



HIGH EFFICIENCY and low installation cost of this pumpless rectifier provide more reliable and economical d-c power. Factory wired, the unit is ready when it arrives to connect and operate.



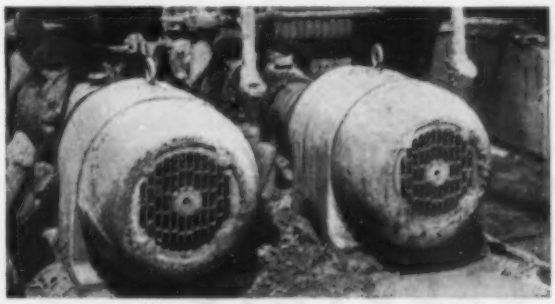
gives up to 50% longer motor life.



NEW G-E TRI-CLAD® '55' MOTORS, totally enclosed, are suitable for damp areas, even where hosing is necessary. New cooling system cleans while it cools motor.

for your plant

G-E MAGNETIC STARTERS and safety switches are compact, for maximum space savings. Short-circuit protection is provided by circuit breaker or fusible disconnect switch.



CORROSIVE ATMOSPHERE effects are greatly minimized in these G-E Tri-Clad induction motors. Rugged cast-iron construction makes them excellent for process application.

SHORT CIRCUIT PROTECTION up to 60,000 amps, plus 50% greater space savings are provided by all-new G-E Limitamp®.

®Reg. Trademark of General Electric Company

SIX G-E ENGINEERING SERVICES . . .

HELP YOU PROTECT YOUR EQUIPMENT INVESTMENT

1 **G-E APPLICATION ENGINEERING** helps you and your consultants design the right electric system for your plant.

2 **G-E ANALYTICAL ENGINEERING** helps attain the optimum electrical system for your application. Engineering experience backed up by electronic system analyzers save valuable design time.

3 **G-E PRODUCT DEVELOPMENT** laboratories design and test new equipment under tomorrow's conditions to meet your future demands.

4 **G-E FIELD-SERVICE ENGINEERING** helps you supervise installation, expedite start-up of your major electric equipment.

5 **G-E MAINTENANCE SERVICE** from 36 G-E Service Shops will repair and uprate your old equipment, help establish productive maintenance of your equipment, furnish emergency service.

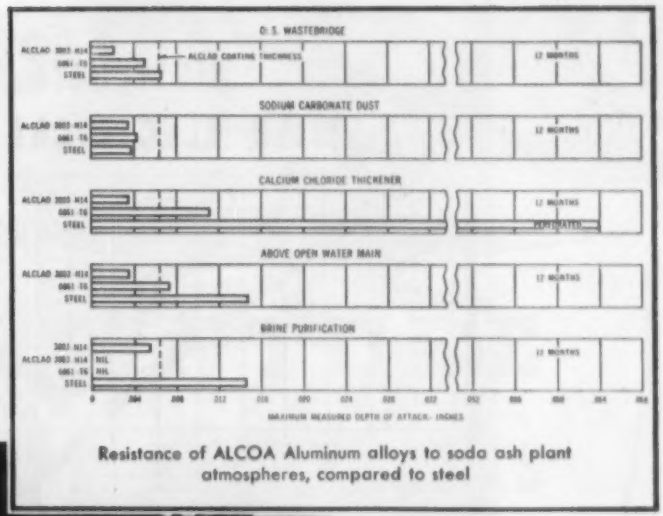
6 **G-E PROJECT CO-ORDINATION** means on-time engineering, shipment, installation of your electric equipment from preliminary diagrams through start-up.

These valuable services are available to you with General Electric equipment. Contact any General Electric Apparatus Sales Office. Meanwhile, for the full story of G-E engineering services, write for brochure GED-2244, General Electric Co., Section 681-5, Schenectady 5, N. Y.

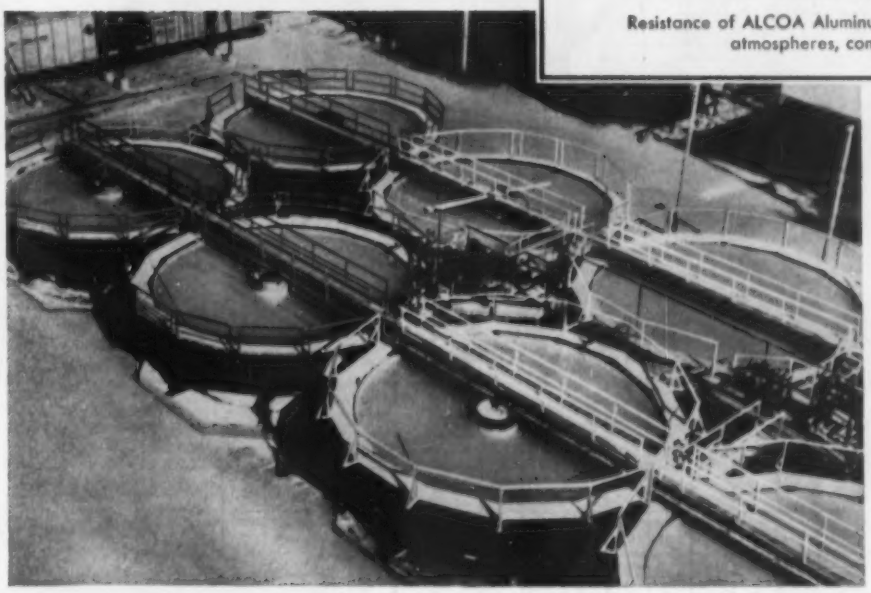
Progress Is Our Most Important Product

GENERAL ELECTRIC

Long service life, exhaustive tests prove Alcoa Aluminum resists soda ash plant atmospheres



Resistance of ALCOA Aluminum alloys to soda ash plant atmospheres, compared to steel



This ALCOA Aluminum alloy 6061 bridge over alkaline brine settling tanks in a soda ash plant is in good condition after eight years' service.

● Exhaustive cooperative tests and years of service are proving the value of ALCOA Aluminum in many soda ash plant installations. One such location is in and around alkaline brine settling tanks, where corrosion is severe. Other ALCOA Aluminum applications in soda ash plants include walkways, stairways, tread plates, handrails, doors, window frames, roofing and siding, heat exchanger tubes, vapor pipes and raschig rings. Field data have corroborated the general acceptability of ALCOA Aluminum in soda ash plants, and have resulted in many additional applications.

● High resistance to corrosion, as proven in applications such as the one above, is the most important property ALCOA Aluminum has to offer to the chemical and process industries. Longer life, reduced maintenance and less downtime result in substantial savings through the use of ALCOA Aluminum.

● Write today for detailed information on how ALCOA Aluminum can be used effectively in your operation. We will be glad to help you with *your* specific problem. Send today for the new 80-page ALCOA book, *Process Industries Applications of Alcoa Aluminum*. It contains the latest performance and design data on ALCOA Aluminum in hundreds of applications. Write on your company letterhead, or use the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America
905-M Alcoa Building
Pittsburgh 19, Pennsylvania

Please send me your new FREE book, *Process Industries Applications of Alcoa Aluminum.*

Name _____

Company _____

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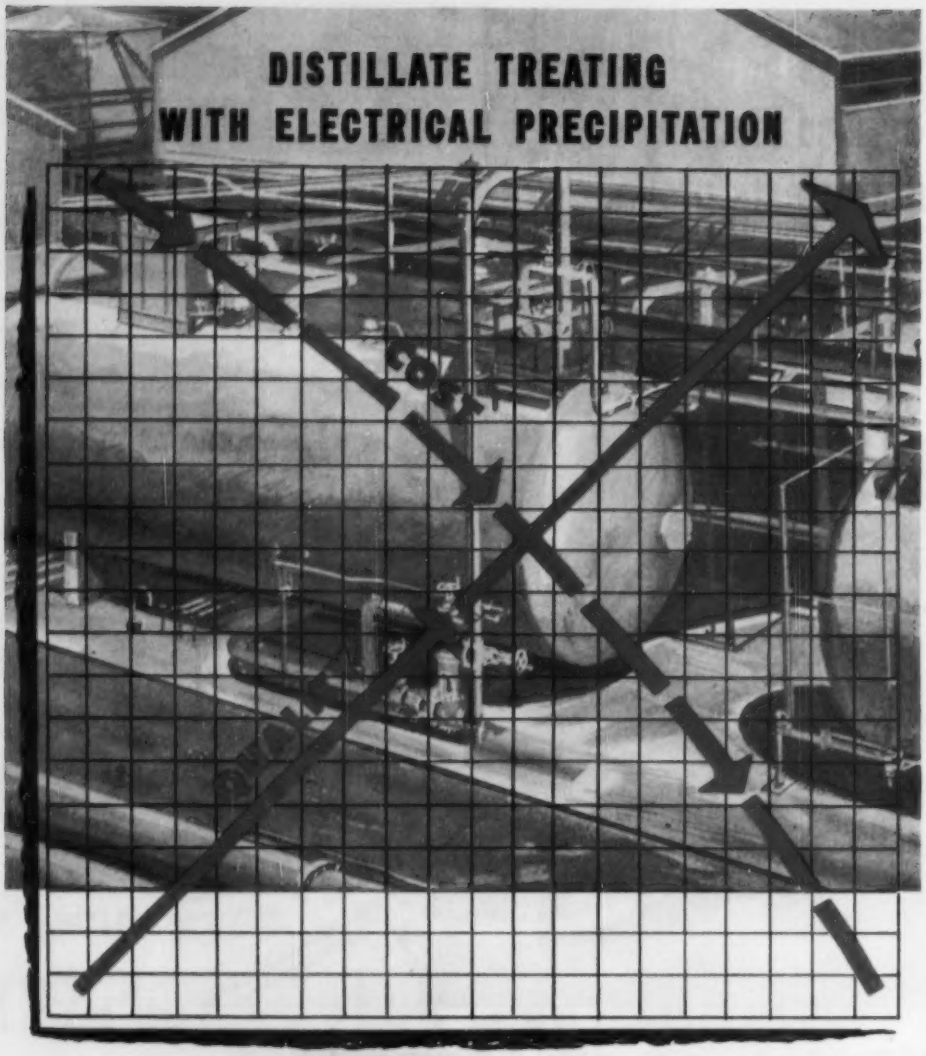
City _____ Zone _____ State _____

For more data on advertised products, use Readers' Service Cards, last page.



NOW A HOWE-BAKER PROCESS FOR GREATLY IMPROVED DISTILLATE TREATING

HIGH PRODUCT QUALITY through efficiency of process to resolve all normal emulsions formed in intimate mixing of distillate and treating agent.

LOWER COST through reduction in carry-over of addition agent, lower chemical consumption, and automatic and continuous operation.

BONUS: Electrical equipment frequently installed in existing vessel.

Learn how Electrical Precipitation can solve your treating problem. A Howe-Baker representative will discuss it with you without obligation.

HOWE-BAKER CORPORATION
ESPERSON BUILDING HOUSTON, TEXAS

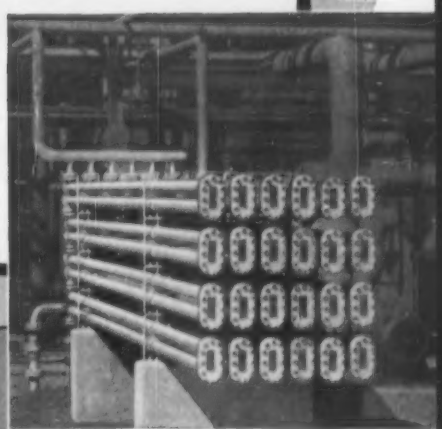
For more data on advertised products, use Readers' Service Cards, last page.

Prevent this Waste!

BROWN FINTUBE

SECTIONAL HEAT EXCHANGERS

Eliminate Obsolescence and Waste in . . .



PILOT PLANT, SEMI WORKS and FULL PLANT OPERATIONS

● Modular design;— can be changed quickly from one product and duty to another by simply adding or removing sections or changing series-parallel manifolding. Pilot operations enlarged easily to semi-works or full plant by direct multiplication keeping all conditions in same relationship. Standard sizes. Interchangeable. Pressures to 22,000 psi. Mild steel, alloy or non-ferrous construction.

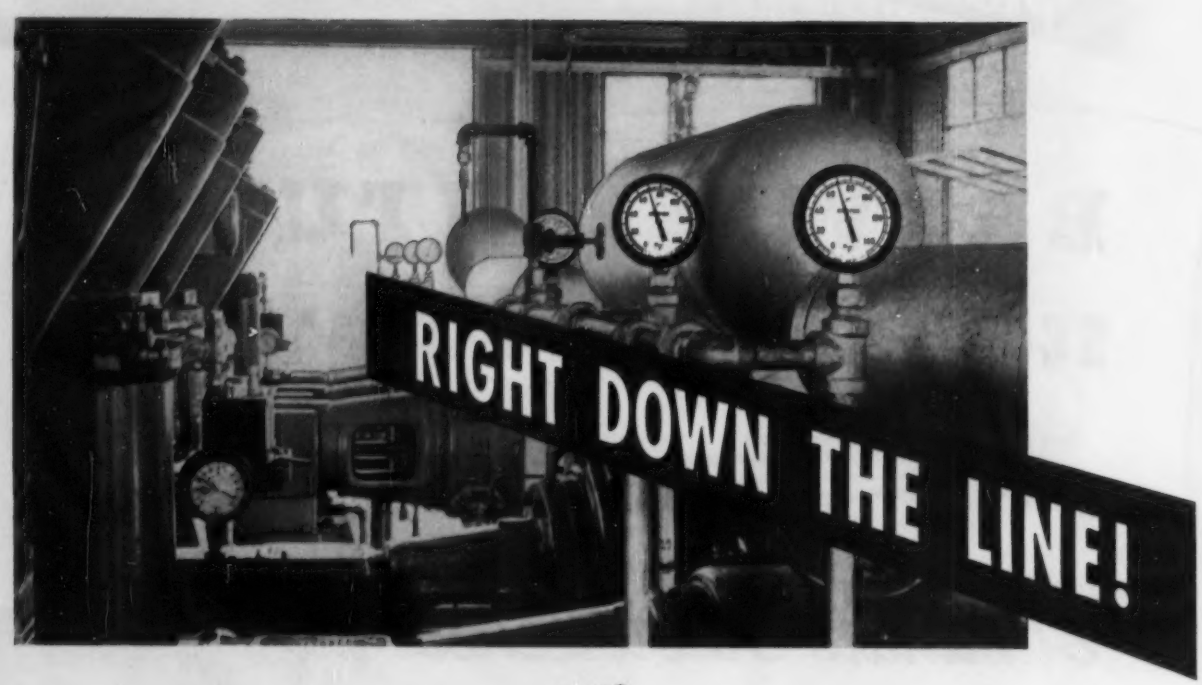
HEAT EXCHANGE SURFACE
BROWN FINTUBE
HEAT TRANSFER PRODUCTS

BROWN FINTUBE COMPANY

Elyria, Ohio

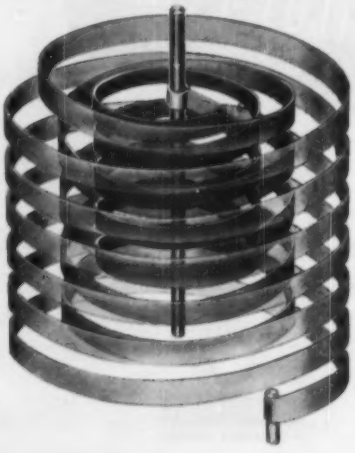
Engineering and Sales Representatives in the Principal Cities

DEPENDABILITY



Weston thermometers with Multiple bimetal helix

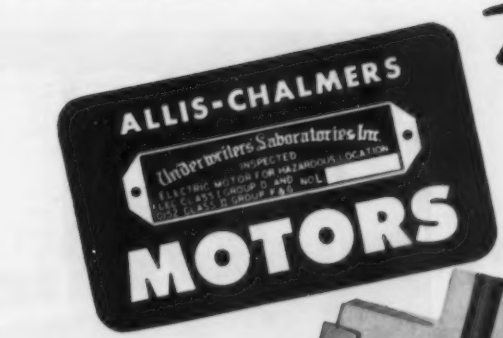
The reasons why WESTON all-metal industrial thermometers excel in dependability and long life . . . enjoy such outstanding preference throughout industry . . . stem in large part from Weston's exclusive design and manufacturing methods. The critical *sensing elements* are all Weston-made in the shorter *multiple helix* form to insure rugged, *nonsagging* units. They are then *cycle-seasoned*, over broad temperature ranges, to insure *consistently precise indications* over far longer periods. Thus they serve better, longer, at far lower over-all costs. Bulletin containing sizes, ranges and prices, available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J.



WESTON
Thermometers

AVAILABLE THROUGH LEADING DISTRIBUTORS

Here is EXTRA MOTOR VALUE



Double-shielded bearing
Large grease reservoirs
Bolted-on bearing cap
Labyrinth seals

This Allis-Chalmers Bearing Design Gives More for Your Motor Dollar

You can lubricate these bearings without dismantling the motor. Pipe-tapped holes in the bearing housings at two points provide means for inserting new grease, flushing out old grease and relieving pressure during re-greasing.

The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, minimizes the possibility of grease entering the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt barriers.

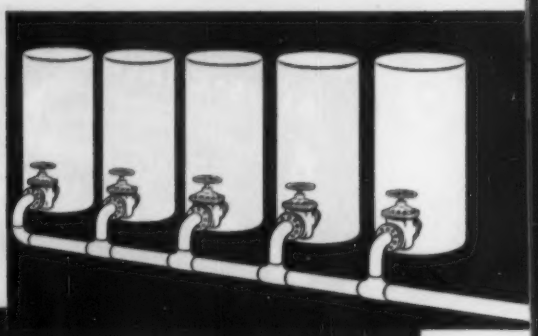
Look for the extra bolts on the end housing . . . the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to give you the facts on this maintenance-saving design. Or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin, for Bulletin 51B7286. A-4855

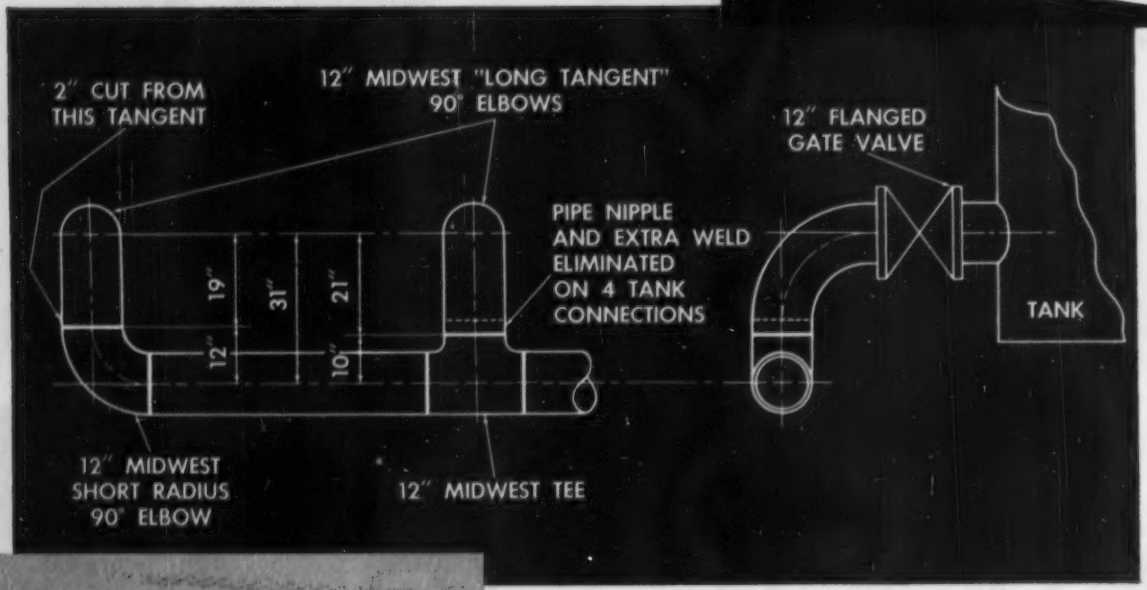
ALLIS-CHALMERS

MIDWEST "LONG TANGENT" ELBOWS

SAVED $156.20

On This Welding Piping





MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS

The Problem:

To connect the five tanks shown in the sketch at top to a common 12" header.

The Difficulty:

The center-to-outlet dimension of the 4—12" tees is only 10", while the shortest elbow available measures 12" center-to-end. Thus, if standard long radius elbows are used next to the five tank valves, four short nipples and four extra 12" welds would be required.

The Solution:

By using Midwest "Long Tangent" elbows as shown in the blueprint, the expense of the four extra nipples and welds was eliminated at the cost of just one cut! The actual net savings made by "Long Tangent" elbows on this job was $156.20.

Remember—Midwest "Long Tangent" elbows cost no more than regular elbows! For further information, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Missouri

Plants: St. Louis, Passaic and Los Angeles

Sales Offices:

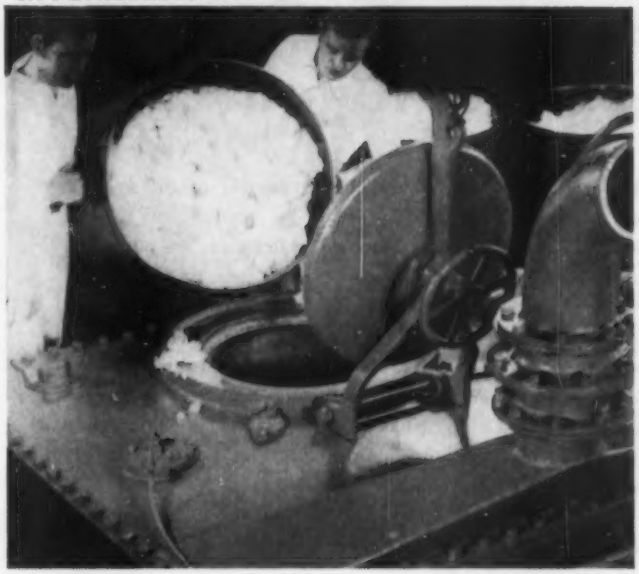
New York 7—50 Church St. ● Chicago 3—79 West Monroe St. ● Boston 27—426 First St. ● Los Angeles 33—520 Anderson St. Houston 2—1213 Capitol Ave. ● Tulsa 3—224 Wright Bldg. ● Cleveland 14—616 St. Clair Ave. ● Miami 34—2103 Le Jeune Rd.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

specify Enjay for fast-paced sales

IN PETROLEUM (*Motor Oil and Gasoline Additives*)



IN CHEMICALS (*Plastics*)

Rely on Enjay for top quality in your product, the kind that makes for growing demand and fast-paced selling. The Enjay Company supplies the petroleum, surface coating and chemical industries with a complete line of uniform, high quality petroleum chemicals backed by 35 years of *proved* results. You can also depend on Enjay for leadership in research and for expert technical assistance in developing new or improved products through chemistry. *Next* time, call Enjay for your chemical needs.

IN SURFACE COATINGS (*Paint and Varnish*)

PETROLEUM	SURFACE COATING	CHEMICAL
PARANOX	PETROHOL 91	PETROHOL 91
PARATONE	PETROHOL 95	PETROHOL 95
PARAFLOW	PETROHOL 99	PETROHOL 99
PARAPOID	JAYSOL	JAYSOL
PARADYNE	Secondary Butyl Alcohol	Iso-Octyl Alcohol
PARATAC	Secondary Butyl Acetate	Decyl Alcohol
PETROHOL	Isopropyl Acetate	Denatured Ethyl Alcohol
Methyl Ethyl Ketone	Acetone	Tridecyl Alcohol
Dewaxing Aid	Methyl Ethyl Ketone	Dicyclopentadiene
Ethyl Ether	Dicyclopentadiene	Isoprene
Isopropyl Ether	Ethyl Ether	Butadiene
Reference Fuels	Isopropyl Ether	Ethyl Ether
RUBBER	Naphthenic Acids	Isopropyl Ether
Enjay Butl	Iso-Octyl Alcohol	Tetrapropylene
Vistanex	Decyl Alcohol	Tripropylene
	Denatured Ethyl Alcohol	Aromatic Tars
		Benzene
		Acetone
		Methyl Ethyl Ketone

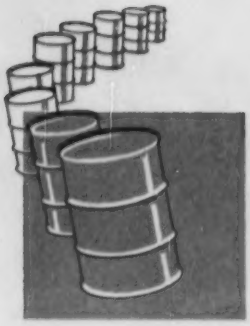
ENJAY

35 successful years of leadership in serving industry

Enjay Company, Inc. · 15 West 51st St., New York 19, N.Y.

For more data on advertised products, use Readers' Service Cards, last page.

Trading Water for Oil



In Southern Illinois, over twenty oil companies have wells in the 10,000 acre Lake Centralia-Salem oil field. When production in this field dropped off, these companies banded together and decided to water-flood the field by pumping water underground through former oil producing wells to force more oil to move to the remaining wells.

What happened? The amount of oil produced has been greatly increased. Today, one well that formerly produced only 5 barrels of oil a day now yields 650!

Up to 130,000 barrels of water a day are pumped into the oil field, yet with the help of automatic devices and pushbutton control, the entire operation of the field takes only a handful of men. Electric power is at work, much of it supplied through the 2500 kva Wagner transformer, shown in the foreground above, that supplies power for equipment in the injection pump house.

Wherever electric power is used, Wagner transformers efficiently and dependably handle their never-ending job of supplying proper voltages for every purpose.

Let a skilled Wagner engineer discuss your transformer needs with you. Call the nearest of our 32 branch offices or write us direct.

Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

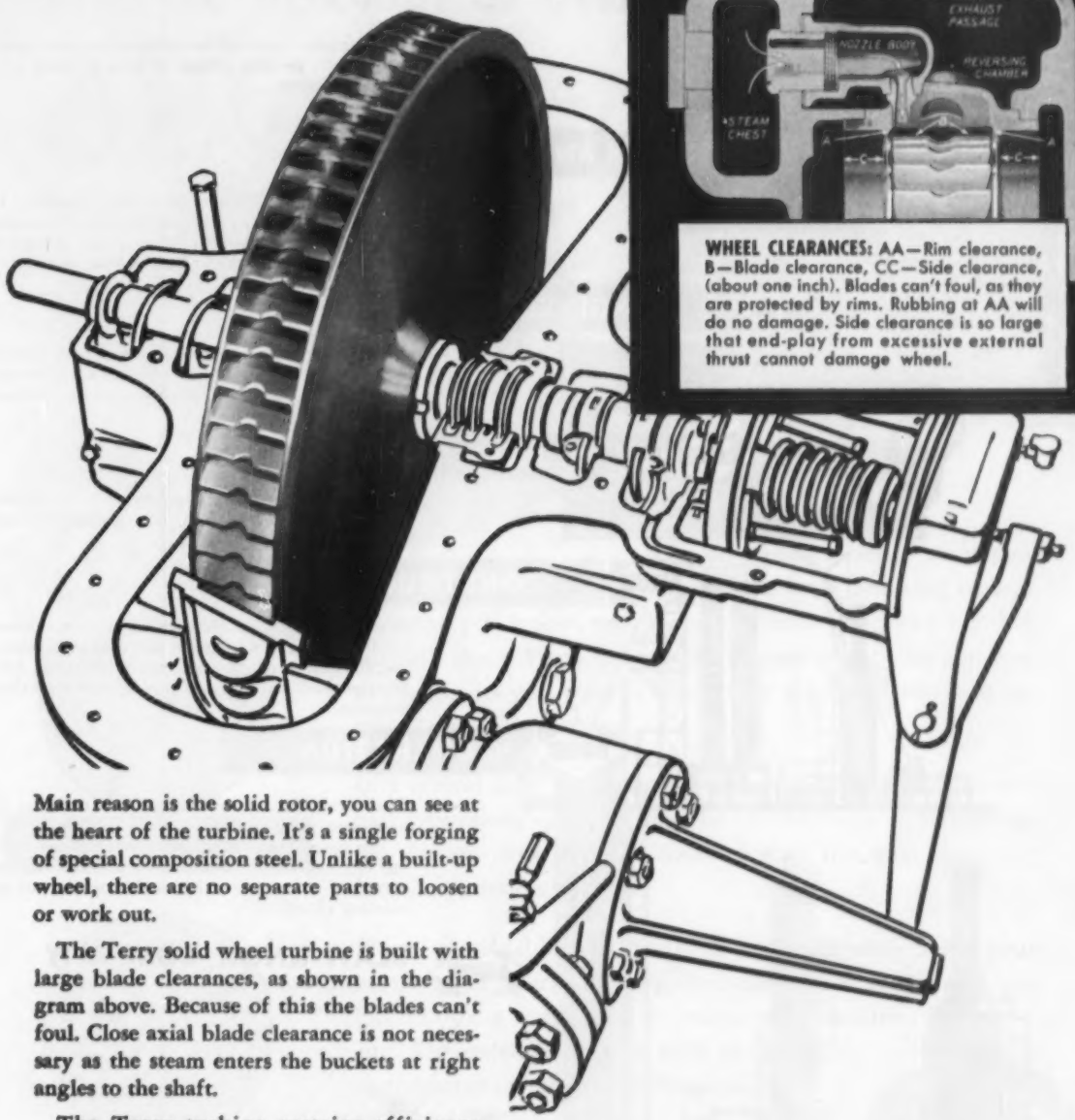
WT59-7

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

WHY TROUBLE GOES OUT

when this turbine goes in

WHEEL CLEARANCES: AA—Rim clearance, B—Blade clearance, CC—Side clearance, (about one inch). Blades can't foul, as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large that end-play from excessive external thrust cannot damage wheel.



Main reason is the solid rotor, you can see at the heart of the turbine. It's a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out.

The Terry solid wheel turbine is built with large blade clearances, as shown in the diagram above. Because of this the blades can't foul. Close axial blade clearance is not necessary as the steam enters the buckets at right angles to the shaft.

The Terry turbine sustains efficiency through the years. Reason: The power producing action of the steam takes place on the curved surfaces at the back of the buckets, so blade wear which might occur is of little consequence.

Bulletin S-116 tells more about these *"Work Horses of Industry."* Send for a copy today.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1202

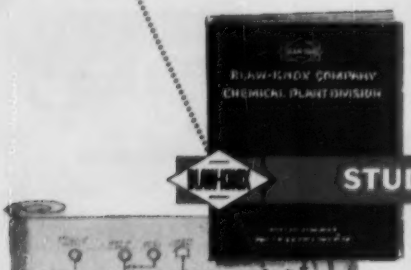
For more data on advertised products, use Readers' Service Cards, last page.

BLAW-KNOX

COMPLETE ENGINEERING AND CONSTRUCTION SERVICES POINT OUT A

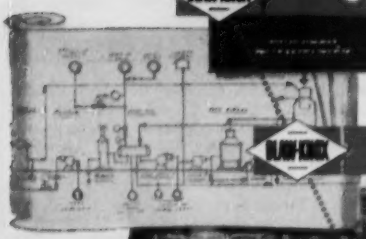
pathway to profits

from initial concept to completion and operation . . . or any phase of the project . . . large or small



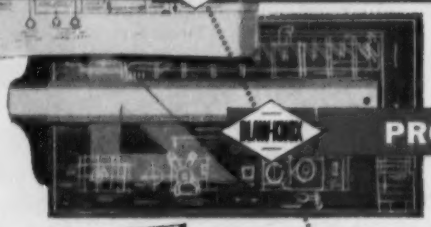
STUDIES AND REPORTS

Technical and Economic studies leading to proper location, capacity, selection of processing methods, design of process plant, design of utilities system and auxiliaries, cost estimates.



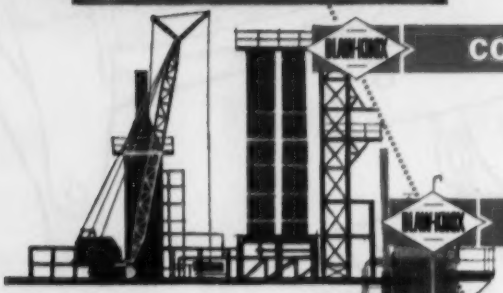
ENGINEERING

Fundamental process calculations, flow sheets, layouts, sizing of units, scale models, design and specification of equipment, piping, instruments, structures.



PROCUREMENT

Fabrication, procurement, expediting of deliveries, and inspection of equipment and materials.



CONSTRUCTION

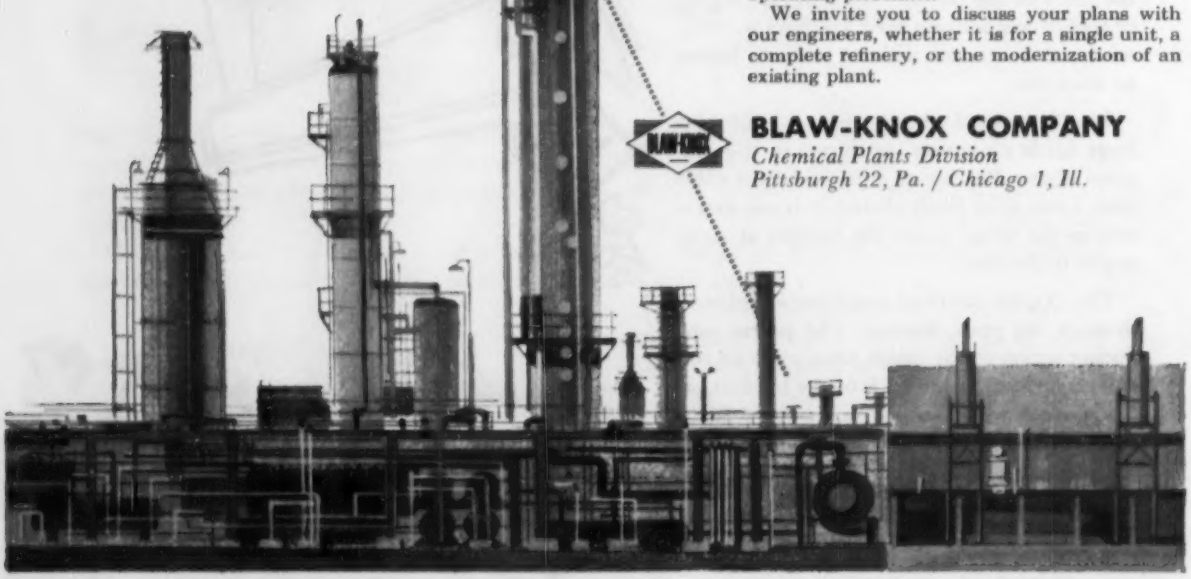
Site preparation, establishment of construction facilities, erection of buildings and structures, installation of equipment and accessories, fabrication and assembly of piping and electrical systems.

OPERATION

Test runs, initial operation, and training of operating personnel.

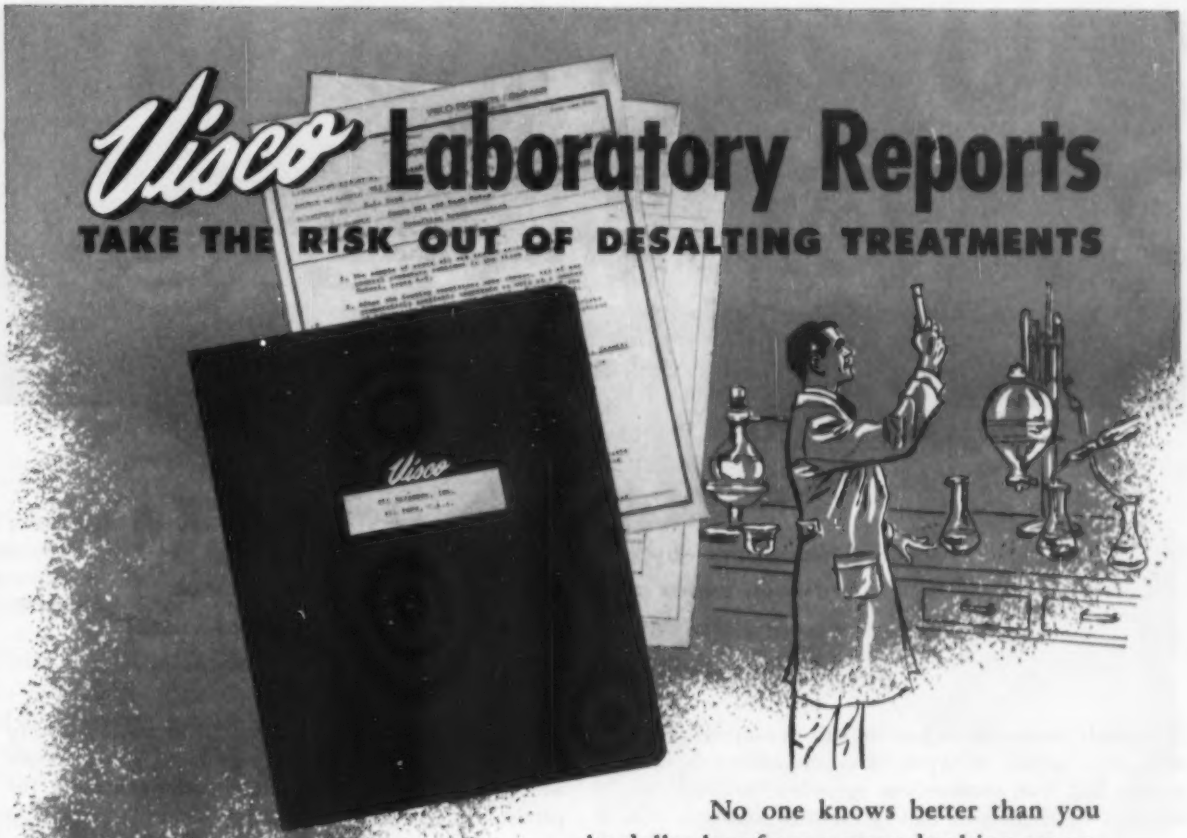
We invite you to discuss your plans with our engineers, whether it is for a single unit, a complete refinery, or the modernization of an existing plant.

BLAW-KNOX COMPANY
Chemical Plants Division
Pittsburgh 22, Pa. / Chicago 1, Ill.



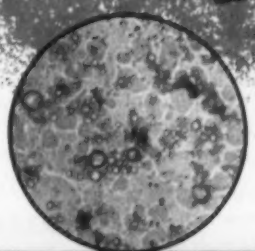
Visco Laboratory Reports

TAKE THE RISK OUT OF DESALTING TREATMENTS



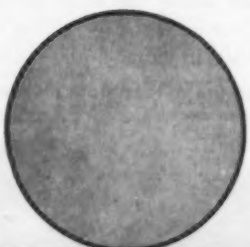
No one knows better than you the dollar loss from a poor desalting set-up.

And you know, too, there's no such thing as a blanket cure-all. But a Visco Laboratory Report *does* point the way to the results you want — from every type of crude — at no added cost to you.



Photomicrograph—
Emulsified refinery crude

In a typical case, 20 or more separate desalting compounds and laboratory formulas may be checked and all contributing factors will be considered before the final desalting recommendation is made.



Photomicrograph—Emulsified refinery crude after Visco desalting

If you would like our desalting recommendation for your crude, send Visco a five-gallon can of the crude and one gallon of the water used in your refinery desalting. Or better yet, check with your Visco representative, and he will arrange for these services.

VISCO PRODUCTS COMPANY
INCORPORATED
2600 Nottingham at Kirby • Houston 5, Texas • Telephone: MAdison 3-0433

Visco® CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS

YORKMESH

DeMISTERS

Assure clean separation between vapor and liquid

Yorkmesh Demisters—by effecting clean separation between vapor and liquid—improve the performance and increase the throughput capacity of any process vessel handling both liquid and vapor phase materials.

Yorkmesh Demisters are knitted wire mesh pads, available in a variety of types, sizes and materials. The unique fine wire construction provides flexibility, resiliency, light weight, high structural strength and extensive surface area. These Demisters are supplied to the exact size and shape required and are usually furnished mounted on light weight open type support grids. Installation is simple in both new and existing equipment.

Vapor-liquid separation efficiency with Yorkmesh Demisters in process vessels is always very high, usually in excess of 99.9%. Where Yorkmesh Demisters are installed in evaporators, distillation columns, gas filters and absorbers, liquid entrainment is substantially completely eliminated.

Pressure drop is so low that it is nearly always negligible. At atmospheric pressure vapor velocities between 2 and 12 ft./sec. are recommended. Under vacuum, depending on conditions, vapor velocities of 30 ft./sec. and higher are possible.

Yorkmesh Demisters are fabricated in a wide variety of materials, densities and wire mesh constructions which are selected to give best performance for the particular operating conditions.

Yorkmesh Demisters are available for prompt delivery in the following materials:

Types 304, 316, 317, 410 and 430 stainless steel
Monel, nickel, Inconel
Aluminum (56-S wire alloy)
Low carbon steel, copper, brass
Also available in Carpenter 20 stainless, Hastelloy B & C, tantalum etc.

The wide experience of the Otto H. York Co., Inc. with thousands of demisters in service provides a sound basis for recommendations that assure the most economical and efficient type of demister for each application. Call on York to solve your problems in vapor-liquid separation.

Complete catalog and list of technical literature (TL54) free on request.

SECTIONAL CONSTRUCTION—recommended for large vessels and for all applications requiring installations through a manhole.

ONE-PIECE CONSTRUCTION—recommended when installation can be made through end of vessel.

Increase throughput capacity!
Improve process efficiency!
Improve overhead quality!
Reduce contamination!
Stop costly liquid loss!

Yorkmesh Demisters are being used successfully in all types of process vessels handling both liquid and vapor phase materials. Some typical examples—

VACUUM TOWERS:
To increase throughput and improve quality of gas oil by separating entrained asphalt. To decrease metals contamination of gas oil. To improve quality of lube distillates.

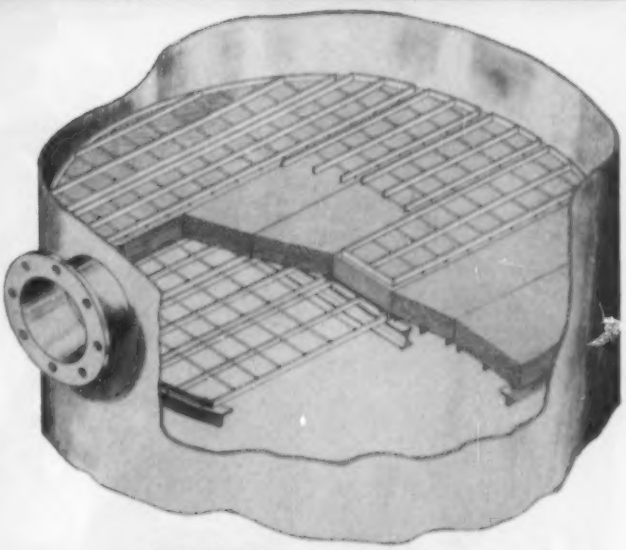
DISTILLATION:
To remove entrained liquid fatty acids from fatty acid vapors. To improve quality of organic product while increasing production. To eliminate glycerin losses.

FLASH TOWERS:
To recover clean naphtha from asphalt solutions. To separate propane from asphalt.

ABSORBERS:
To remove absorption oil from natural gas. To prevent loss of glycol and amine solutions.

EVAPORATORS:
To produce high purity steam from concentrated caustic soda solutions. To stop entrainment losses from valuable fluoride solution.

KNOCK-OUT DRUMS:
To remove water and oil from air. To remove fatty acids from superheated steam. To reduce compressor maintenance by removing liquid entrainment from the gas.



SECTIONAL TYPE DEMISTER IN PLACE—cutaway view.

STEAM DRUMS:
To eliminate liquid entrainment in order to produce high quality, high purity steam.

GAS FILTERS:
To clean manufactured gas. To separate sulfuric acid and solids from chlorine gas.

COMPRESSORS:
To separate entrained liquids from compressor discharge gasses.

SCRUBBERS:
To separate water from natural gas. To eliminate mist from flue gas. To remove natural gasoline from natural gas.

HOW TO GET THE BEST PERFORMANCE—

Send us details on type of process vessel or operation (absorber, vacuum tower, evaporator, knock-out drum, etc.); vapor flow rate, pressure, temperature, and density or molecular weight; liquid rate, viscosity, and specific gravity; for existing equipment advise dimensions, indicate vertical or horizontal vessel, and material of construction required. Furnish a drawing or sketch if possible. Complete details will enable us to make a precise recommendation and price quotation.

YORK

OTTO H. YORK CO., INC.

6 CENTRAL AVE. • WEST ORANGE, N. J.

"clean separation between vapor and liquid"

For more data on advertised products, use Readers' Service Cards, last page.

Evenly matched or not...

there's enough difference to make all the difference

Before the bout, two fighters may look equally good to the fans. After a round or two, the differences begin to show up.

It's the same with heat exchanger tubes. They all start out looking pretty much alike, but under the test of day-in, day-out operation, Scovill Phosphorized Admiralty Heat Exchanger Tubes have consistently shown superior performance.

Hot-extrusion from Scovill Continuous-Cast billets means uniformity in the metal, uniformity of chemical composition and grain structure, uniformly high phosphorus content. It means sounder metal—smooth, dense, free from pits or porosity. These—plus Scovill's unrivaled Technical Application Services—are, indeed, differences that make *all* the difference in economical, uninterrupted service under tough operating conditions. Let us tell you more about them.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL

HEAT EXCHANGER TUBE

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

35CS9

MAXIMUM FLOW

characteristics

with MINIMUM pressure drops

ORBIT VENTURI VALVES

When you buy Orbit Forged Steel Venturi Valves, you can be sure that they are designed to give maximum flow characteristics with minimum pressure drops.

Three important features of the Orbit Forged Steel Venturi Valve design are:

1. *The tapered sections are smoothly machined and are gradual so as to eliminate serious frictional losses.*
2. *The diverging conical downstream passage reduces pressure drops to a minimum.*
3. *The entrance and exit walls of the conical sections are held at minimum angles.*

Orbit Venturi Valves are compact in design yet are built for continuous heavy duty service.

Available in flanged end only, ASA Class, Carbon Trim, Stainless Trim, Sizes: 2″, 2½″, 3″, 4″ and 6″, beginning with 150 Lb. Class.

Available also in Full Round Opening ASA Class, Sizes: 1″, 1½″ 2″, 2½″, 3″, 4″, beginning with ASA 300 Lb. Class. Screw and Flanged Ends.

ORBIT VALVES ®

ORBIT VALVE COMPANY

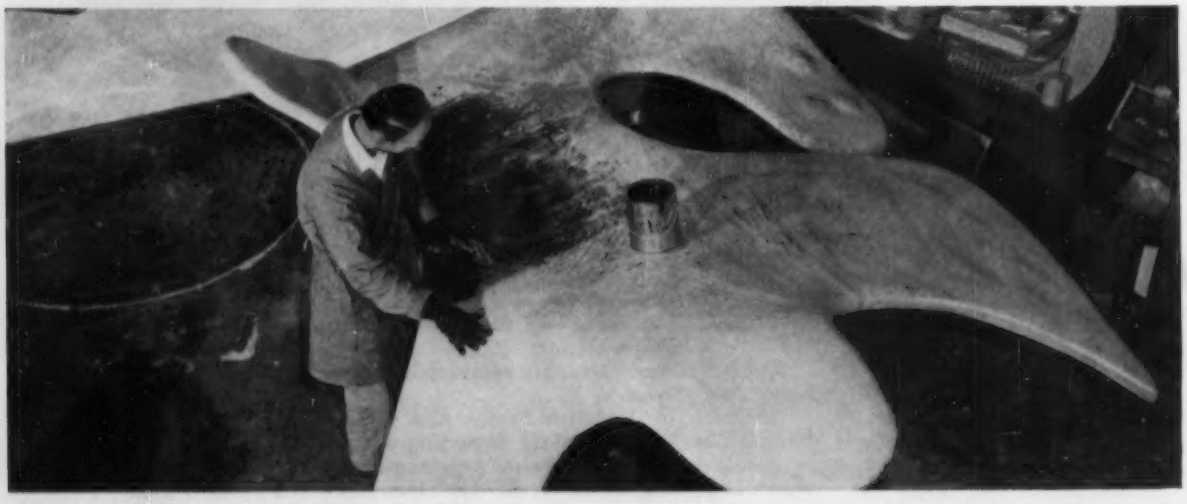
P. O. BOX 699 TULSA, OKLAHOMA

SHELL REPORTS

A PICTURE ROUND-UP OF SOME ACTIVITIES THAT MADE NEWS OUTSIDE THE PETROLEUM WORLD

CRYSTAL BALL. To "zero in" on off-shore drill sites with pin-point precision, Shell engineers came up with this spinning, mirrored marker. The "crystal ball" rotates atop a buoy in an off-shore exploration area. Ashore, surveyors on two eighty-foot towers spot the marker by its dancing reflections and "fix" the new drill site. Shell's efficient handling of such everyday problems means faster development of off-shore oil exploration — a vast new reserve for America to count on.

SAFETY IN NUMBERS. Safety at Shell is a full-time job. In this demonstration a .22-caliber bullet is fired into the safety lens of protective goggles. Even with a direct hit, the safety lens will not shatter! Recently, safety-conscious Shell people at the Wilmington-Dominguez Refinery, Calif., amassed a record of almost 4,000,000 man-hours without a lost-time accident. Records like this mean safer working conditions and lower cost, better quality products for everybody.



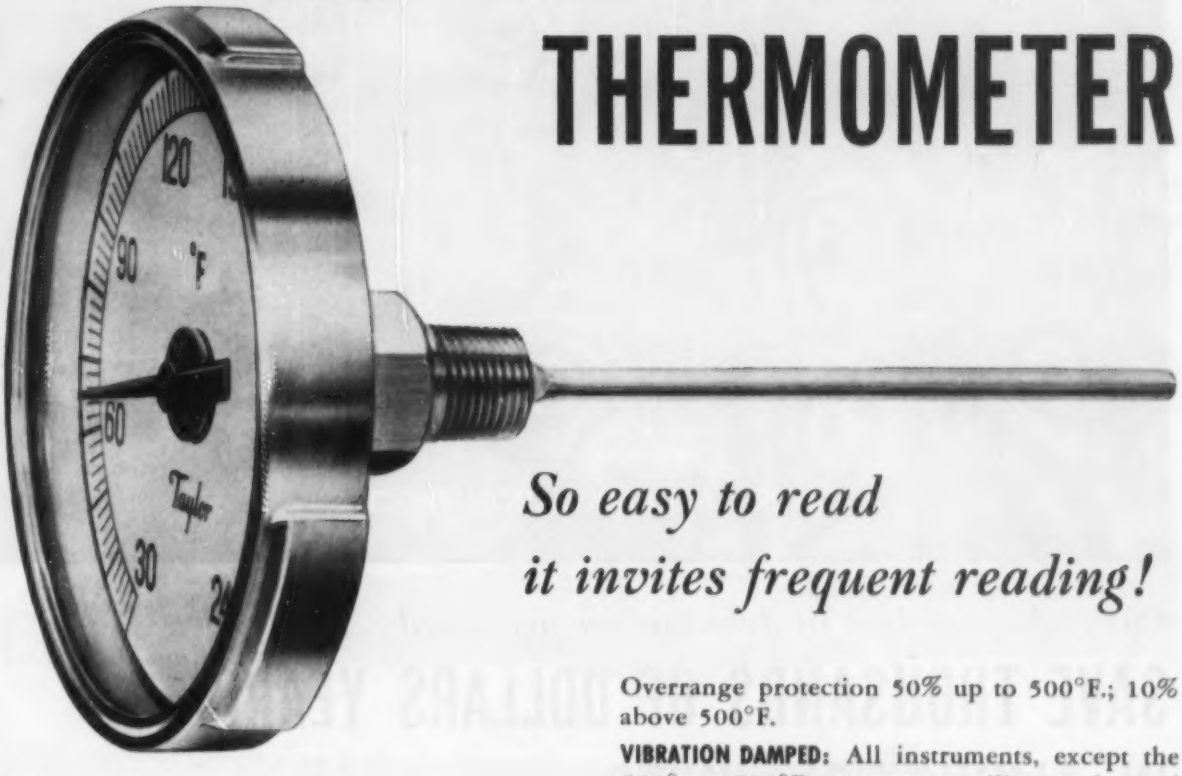
BUILD A HILL. A boy forever needs a hill to climb — and this designer in Oakland, Calif., is making one. Using a fabric impregnated with Shell's new EPON® resin, a strong, safe "mountain" is formed for active youngsters to climb up and over. This is only one of the many uses found — and yet to be found — for versatile Shell EPON resin. The potential of EPON resin is so great that each week Shell researchers are developing more and more useful and necessary products from it. Shell people work for new methods, new products, and new ideas for easier living.

SHELL

For more data on advertised products, use Readers' Service Cards, last page.

Traditional Taylor accuracy in a low cost instrument

THE NEW BI-THERM* 5" DIAL THERMOMETER



So easy to read
it invites frequent reading!

A SIMPLE, dependable and economical thermometer with many applications throughout the petroleum field, such as, Heat Exchangers, Pipe Lines, Storage Tanks, Field Treaters. Wide variety of ranges from minus 40° to +750°F. Also available with three inch dial; stem lengths of 4, 6, 9, and 12 inches; separable wells of brass, steel, type 304 stainless steel or monel.

EASY TO READ: The large dials are highly readable because of black figures and graduations on an aluminum background.

RUGGED: All exposed metal parts are of arc welded, corrosion-resistant stainless steel. All instruments are waterproof. All mechanical connections are welded for greater reliability.

ACCURATE: These instruments are accurate within ±1% of range, over the entire range. Simple zero-setting features correct minor errors in readings which might result from severe mechanical shock. No ambient temperature effect. Overrange protection 50% up to 500°F.; 10% above 500°F.

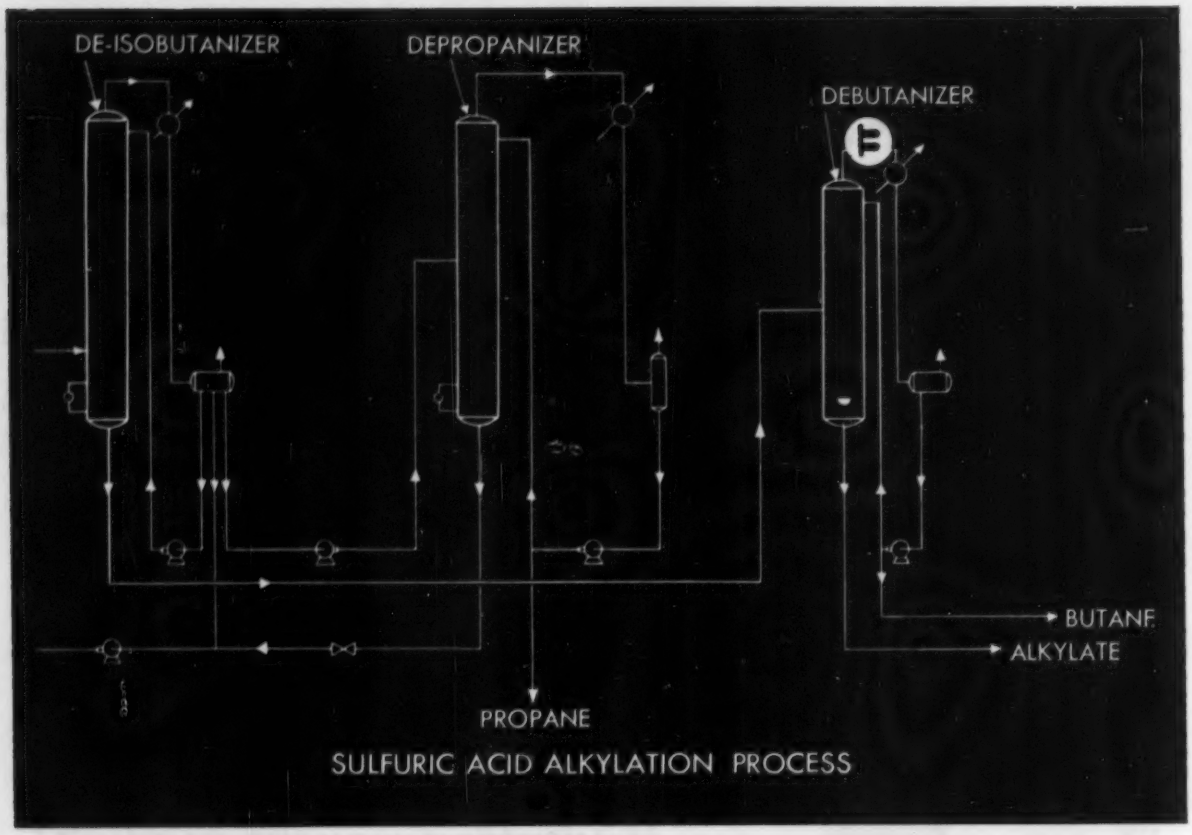
VIBRATION DAMPED: All instruments, except the 200° to 750°F. range, are silicone damped against vibrations. Result is increased speed of response, no zero-shift due to shock, minimum pointer vibration, and elimination of pointer chatter when the thermometer is handled.

ECONOMICAL: Costs only **$16** to **$26,** depending on dial size and length of stem. Ask your Taylor Field Engineer, or write for **Bulletin 98267.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

*Trade Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

For more data on advertised products, use Readers' Service Cards, last page.



Cut isobutane loss in debutanizer overhead . . .

SAVE THOUSANDS OF DOLLARS YEARLY IN ALKYLATION UNITS *with Continuous Analyzers . . .*

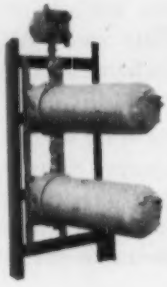
P-E TRI-NON* Infrared Analyzers can increase alkylation unit profits by reducing loss of valuable isobutane in spent butane streams. The isobutane savings per analyzer are on the order of $20-$60,000 per year depending upon through-put. Continuous analyses also increase profits by eliminating labor required for periodic sample testing.

An analyzer sensitized to isobutane, at the debutanizer overhead, provides information to the operator with which he can control either the butylene-isobutane feed ratio, or deisobutanizer operating conditions. "Analytical lag" is eliminated by moving the laboratory right onto the process line.

P-E instruments can analyze and control to ± 1%. They need no special housing, require no complicated automatic standardization. They provide the best zero and range stability available.

When you specify continuous analyzers for your process streams, only P-E has a complete line of instruments to choose from. Or let us develop a complete analytical control system for you. Nowhere else can you get the combination of chemical engineering and instrument know-how that you'll find at P-E. *T. M.

Perkin-Elmer
CORPORATION
Norwalk, Connecticut



P-E TRI-NON Analyzers are available in a wide range of models and prices to meet all types of continuous analytical problems. They are rugged and dependable, expressly designed for use in the varied environments of a processing plant or refinery. For quick and easy maintenance, instrument components can be tested right on stream — without disconnecting.

The true cost of an expansion joint is not the figure on the manufacturer's price tag. Many factors enter into any such cost determination. For example, an expansion joint that fails just when it shouldn't could wreck a plant and cost a small fortune. And, assuming equal first-cost of any two competitive manufacturers' designs, one that stands up twice as long as the other . . . costs only half as much on a unit-time basis. So, one really shouldn't count on "price" as a measure of value.

But here is one thing you can count on. Every single expansion joint in the Zallea line is designed and built to assure maximum reliability —and top value for your dollar. This is no empty boast, but a fact that can be confirmed for you by figures.

So, whenever you have problems—or needs—relating to expansion joints, don't fail to get in touch with Zallea. Write today for Bulletin 351, containing condensed descriptions of the many types. There is a Zallea joint for every requirement.

Zallea expansion joints

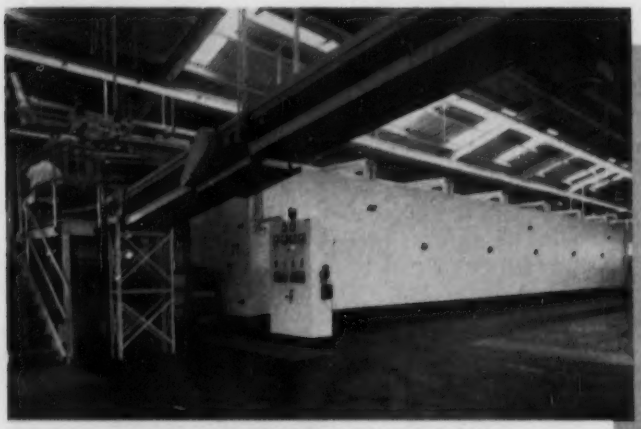
ZALLEA BROTHERS, 890 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

For more data on advertised products, use Readers' Service Cards, last page.

WAX PRODUCERS

take the labor and floor space out of wax moulding



15,000 lb./hr. GREER Moulder installed at prominent East Coast refinery.

Machine Discharge Station with complete control over operation and inspection.

WRITE
Helpful, informative 9-page bulletin tells how a GREER Moulder saves labor and space; ups quality control.

. . . CONSIDER THESE ADVANTAGES WHICH A GREER AUTOMATIC WAX MOULDER GIVES YOUR PLANT:

AMAZING LABOR SAVINGS
. . . because one man and a Greer Moulder can slab up to 15,000 pounds of wax per hour. Users report labor savings of up to 85%.

SPACE SAVINGS, TOO
Automatically deposits, cools, and demoulds, all in approximately 1/10th the floor space ordinarily required by batch processes of equal capacity.

PRECISE WEIGHT CONTROL
Volumetric Depositor holds cakes within ±½ of 1% in weight for a given setting. Saves spot checking labor. No air entrapment.

SANITARY
Wax is untouched from time it leaves storage tank to finished cake.

●

NOW AVAILABLE
New 2500-7500 lb./hr. model (10-pound cakes) in addition to standard 7500-15000 lb./hr. GREER Wax Moulder.

J. W. GREER COMPANY

WILMINGTON, MASSACHUSETTS
Sales Engineering Offices: Chicago, Ill., San Francisco, Calif.

GREER

SMALL BUT MIGHTY BIG!

It's just a simple hex nut—but it can easily prove vitally important to the successful completion or the efficient operation of a single unit or a complete processing plant.

That's just a good reason why careful attention to every detail of construction is highly significant to Procon. Constant alertness to the proper application of every component part—making sure that nothing is left to guesswork—results in better all-around construction.

Perhaps the best proof of such construction efficiency is most adequately evidenced by the number of companies that have selected Procon to handle a second, third and even a fourth construction project.

It's that kind of confidence that makes us realize even the smallest nut may prove a mighty big factor in our continued progress.

PROCON *Incorporated*
1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

PROCON *(Canada)* LIMITED
40 ADVANCE ROAD, TORONTO 18, ONTARIO

PROCON (*Great Britain*) LIMITED
112 STRAND, LONDON, W. C. 2

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

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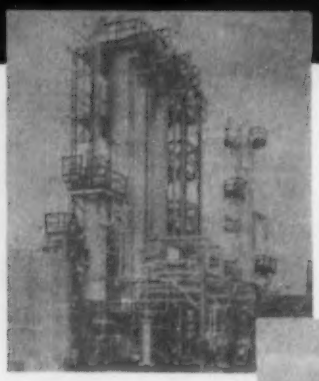
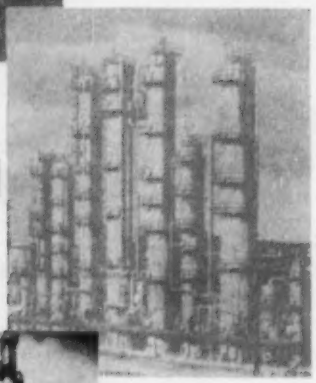
Experienced

IN PLANT AND UNIT DESIGN
from Crude to Finished Product

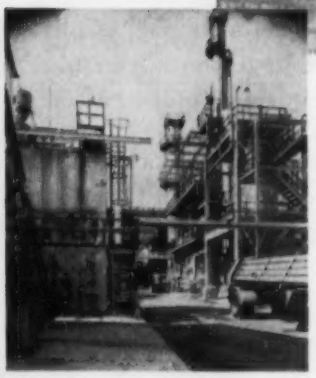


CONVERSION



SEPARATION

PURIFICATION *

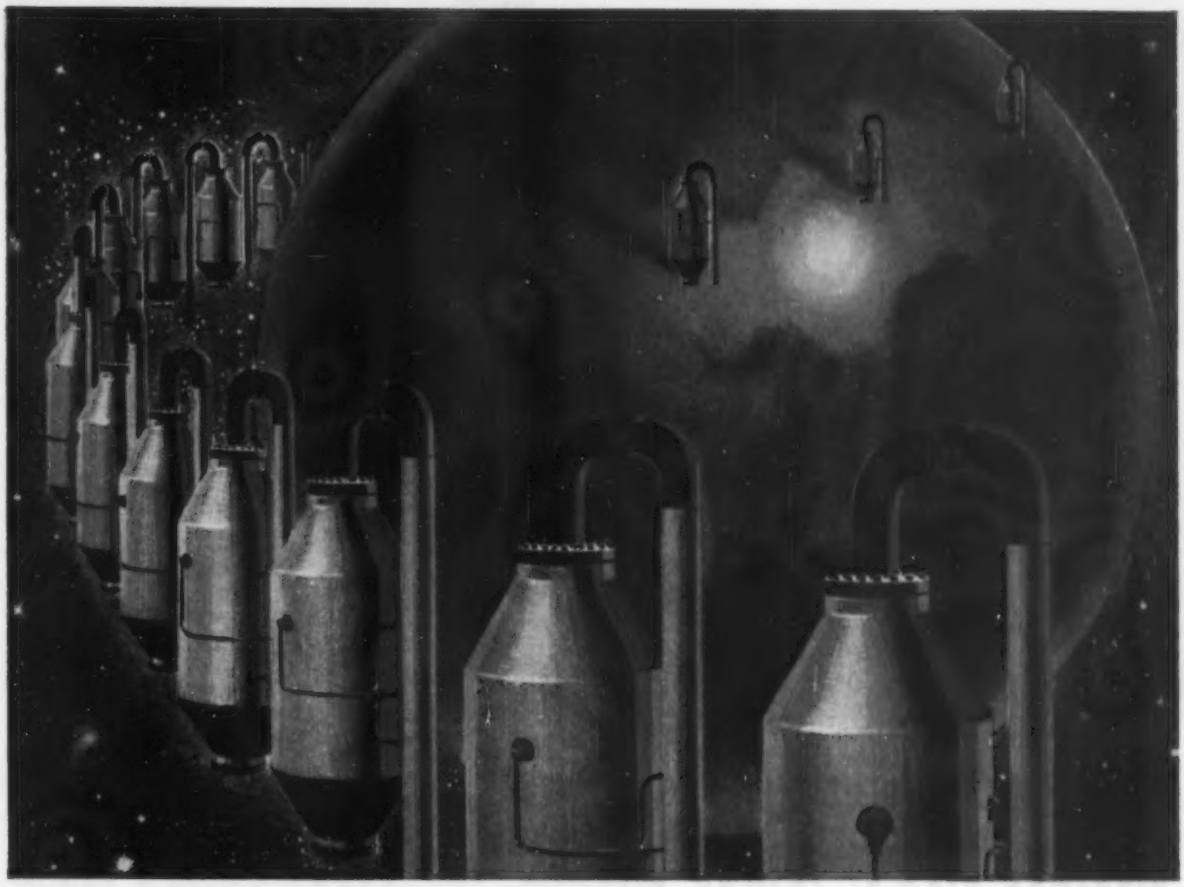


mBc

* The removal of trace impurities from end products is the most critical step in many processing schemes. We have had broad experience with azeotropic and extractive distillation; selective absorption and adsorption; and the many other tools for high degrees of refining.

BADGER MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASS. • 60 EAST 42nd STREET, NEW YORK 17, N.Y.



Now...Thanks to Catforming...

HIGH OCTANES, HIGH YIELDS AT LOW COST!

Today, well into its third year of commercial operation, Atlantic's Catalytic Reforming Process is proving its ability to give superior results on a broad variety of feed stocks.

Catforming's simplicity brings savings through increased efficiency every step of the way—actually cutting out many intermediate steps.

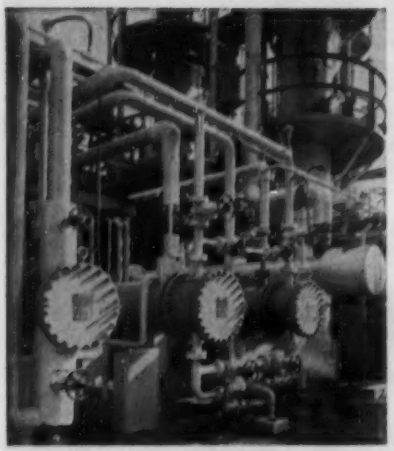
Regardless of the size of your operation or the nature of your charge stock, Catforming merits your attention. One reason Catforming has "proved out" commercially is Atlantic's broad experience in all phases of petroleum refining.

Phone or write for our detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

it's the CATALYST that counts

ATLANTIC

For more data on advertised products, use Readers' Service Cards, last page.



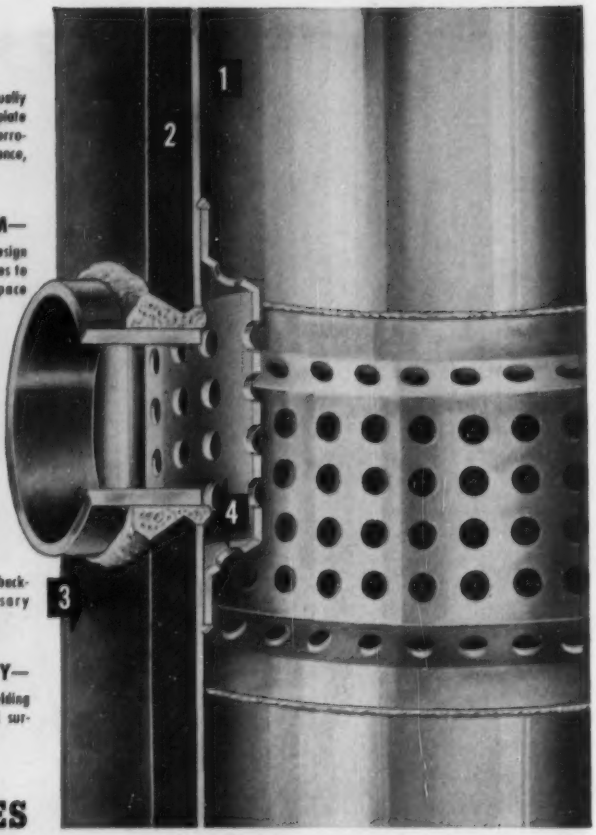
Stainless-clad steel checks corrosion in these acid stripping and cooling units handling naphthenic acid at 350° F.

1 ECONOMY—
High alloy layer—usually 10% or 20% of total plate thickness — assures corrosion and abrasion resistance, long equipment life.

2 DESIGN FREEDOM—
Integral bond allows design and fabrication of shapes to meet process and space needs.

3 STRUCTURAL STABILITY—
Low-cost carbon steel backing provides necessary strength and rigidity.

4 EASY TO MODIFY—
Normal cutting and welding will not endanger clad surface or bond.



CLAD STEEL EQUIPMENT ASSURES

LONG LIFE AND EASY MODIFICATION

To help you lengthen profitable service life *and* overcome the factor of high first cost, clad steel equipment offers two unique advantages. First, clad steel construction permits easy tank and pressure vessel revision when new openings must be cut and flanges or pipes welded on. The bond between cladding and backing is not affected by the temperature range where clad can be applied. This eliminates seepage and crevice corrosion.

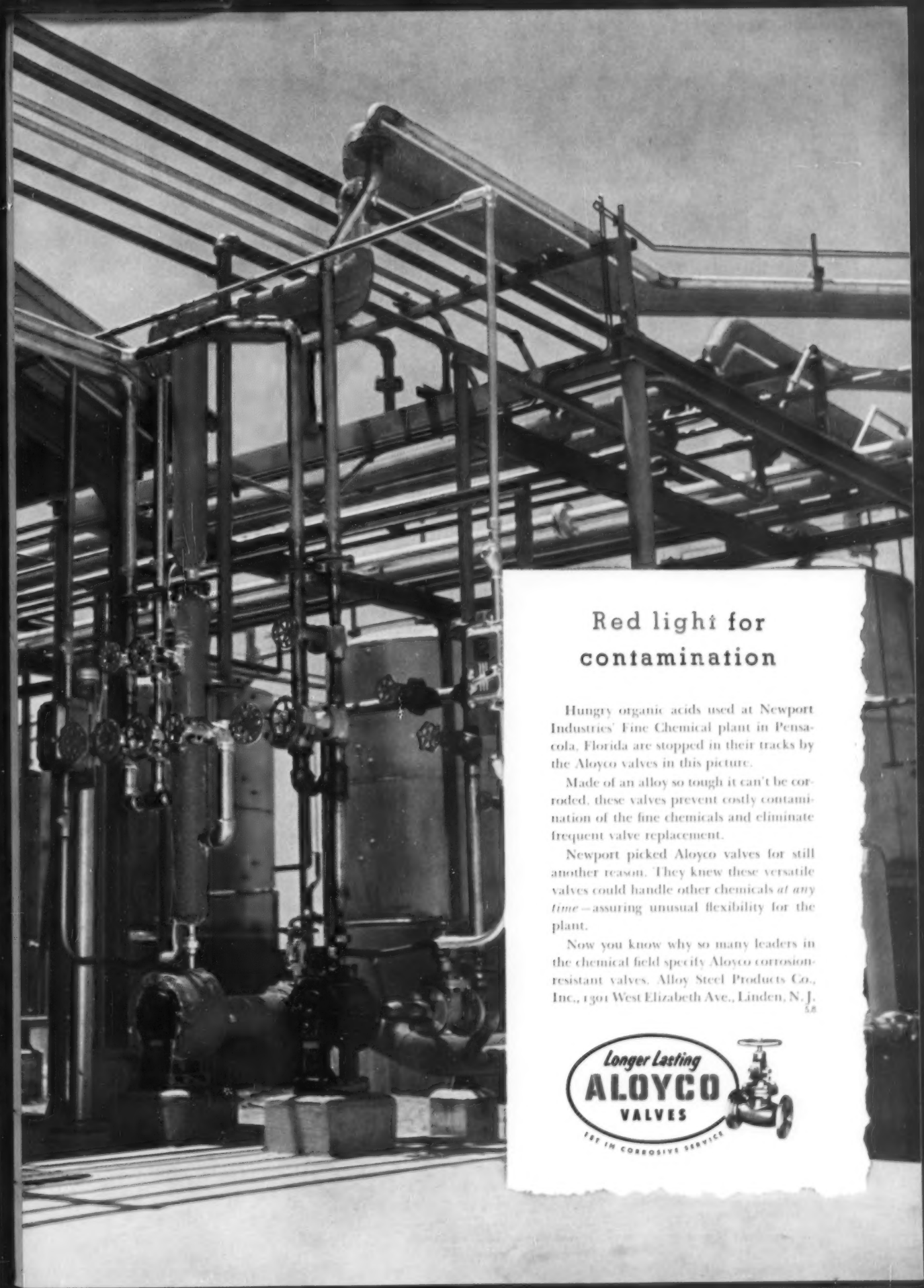
Second, you get all the benefits of solid high alloy's corrosion resistance and protection with savings up to 50% in material costs. Because cladding and backing are bonded over their entire surface, the API-ASME Code permits full gage consideration for design purposes.

Long service life and low cost protection, plus other advantages such as economical field erection and easier drainage, cleaning and inspection, can be obtained from 16 cladding materials. *Qualified* equipment builders know best how to apply these to your new processing equipment. By working with your own engineers and consultants from the start, they can help you get longer equipment life at lower cost. Lukens offers the widest available selection of clad steels—stainless, nickel, Inconel, Monel, copper—and cooperates with fabricators in helping you to select the type best suited to your needs. If you would like more information, consult one of your builders or write Manager, Marketing Service, Lukens Steel Co., 751 Lukens Building, Coatesville, Pa.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE



Red light for contamination

Hungry organic acids used at Newport Industries' Fine Chemical plant in Pensacola, Florida are stopped in their tracks by the Aloyco valves in this picture.

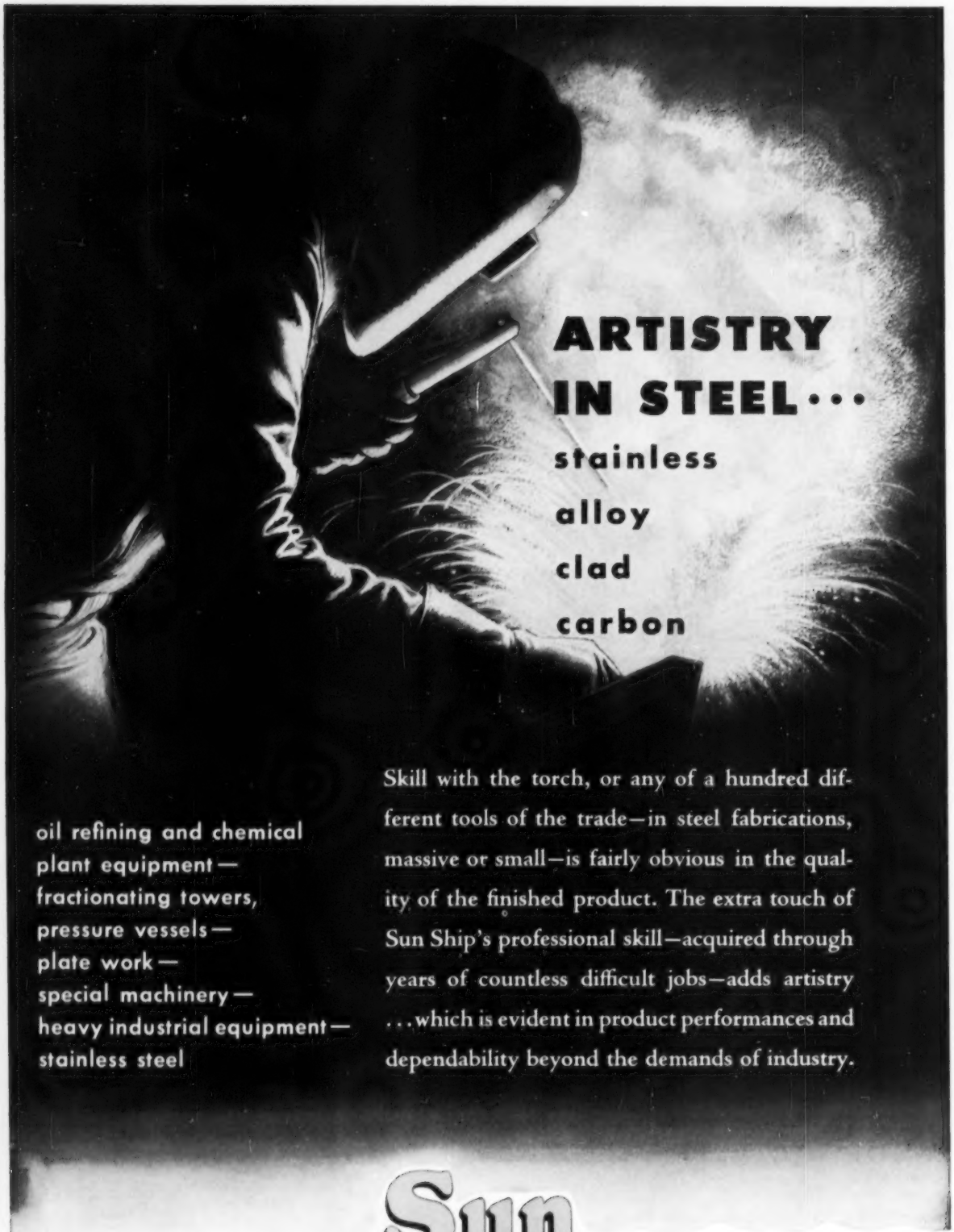
Made of an alloy so tough it can't be corroded, these valves prevent costly contamination of the fine chemicals and eliminate frequent valve replacement.

Newport picked Aloyco valves for still another reason. They knew these versatile valves could handle other chemicals *at any time*—assuring unusual flexibility for the plant.

Now you know why so many leaders in the chemical field specify Aloyco corrosion-resistant valves. Alloy Steel Products Co., Inc., 1301 West Elizabeth Ave., Linden, N. J.

5.8

Longer Lasting
ALOYCO
VALVES
FOR IN CORROSIVE SERVICE


ARTISTRY
IN STEEL...
stainless
alloy
clad
carbon
oil refining and chemical
plant equipment—
fractionating towers,
pressure vessels—
plate work—
special machinery—
heavy industrial equipment—
stainless steel
Skill with the torch, or any of a hundred different tools of the trade—in steel fabrications, massive or small—is fairly obvious in the quality of the finished product. The extra touch of Sun Ship's professional skill—acquired through years of countless difficult jobs—adds artistry ...which is evident in product performances and dependability beyond the demands of industry.

Sun

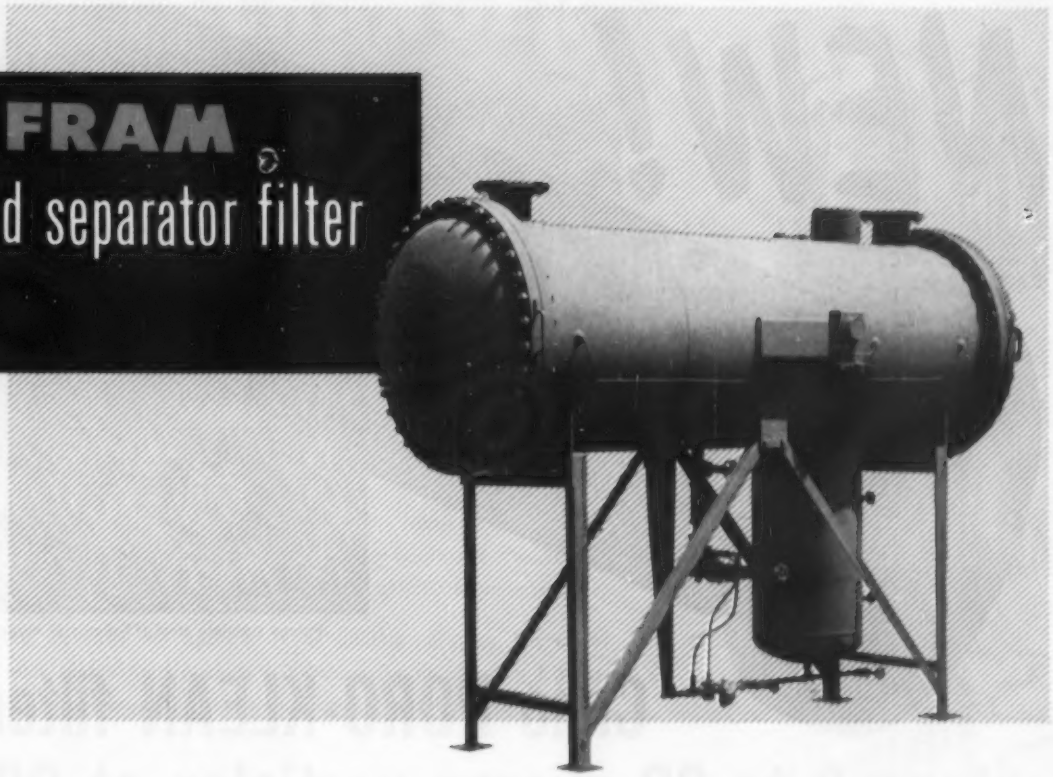
SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

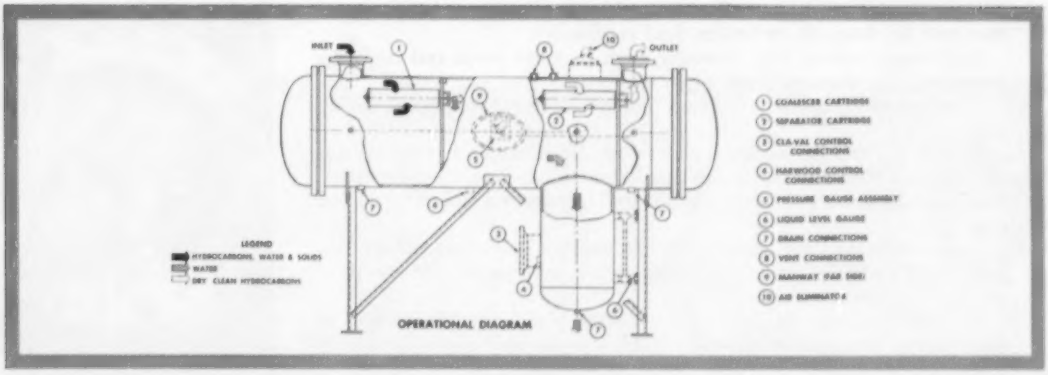
ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

FRAM® liquid separator filter



Removes the water cloud and solids from light petroleum products.



Here is the sure way to obtain clean, water-free petroleum products — the FRAM Liquid Separator/Filter is designed for use in refinery process streams and petroleum marketing installations to remove entrained water and solids (down to 5 microns) from gasoline, jet fuel, diesel fuel, kerosene, burning oils. Capacity is from 5 to 1000 GPM. Built to API-ASME Code. Send for Bulletin.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF FRAM CORPORATION

For more data on advertised products, use Readers' Service Cards, last page.

NEW!

Porous stainless steel (15-diameter magnification)

Cuno PORO-KLEAN filter stops 3-to 30-micron particles at 900°F

Cuno's new PORO-KLEAN offers true micronic filtration at temperatures that melt tin, bismuth, cadmium, lead or zinc.

High temperatures, high viscosity, high pressure drops and corrosive fluids don't faze this new filter.

It's all metal—absolutely lint-free. There's no contamination of the filtered fluid.

It's strong. PORO-KLEAN filters already in operation take a pressure drop of 1500 psi. PORO-KLEAN porous stainless steel has been used for structural parts in aircraft to achieve boundary layer control and transpiration cooling.

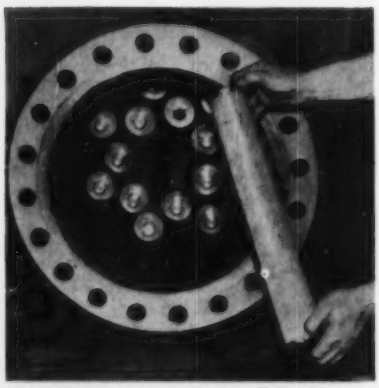
It's corrosion resistant. Standard in 316 stainless steel. Low carbon content (0.03 to 0.05% max.) prevents carbon precipitation at welds or during fabrication.

It's easily cleaned—in place, by backwashing with pre-filtered fluid or inert gas; or, when removed, with suitable solvent. May be sterilized with live steam for food or drug processing; or will filter rust and scale from steam used for other cleaning or sterilizing.

Its porosity is closely controlled. Four standard grades cover the range from 3- to 30-micron statistical particle retention.

Standard designs. For most applications standard housings and elements are available.

Get all the facts on Cuno's new PORO-KLEAN filter for your chemical or process applications. Write Cuno Engineering Corporation, 33-12 South Vine Street, Meriden, Conn. 53



THIS PORO-KLEAN FILTER handles 180 gpm of naphtha at 400°F. Operating pressure: 700 psi ASME Code with 5 psi pressure drop. It's cleaned by back-flushing with nitrogen. Cell-type PORO-KLEAN filter elements (large picture at top) have large surface area. This unit is 54" L x 9" O.D. and is designed for 1500 psi pressure drop and 550°F.

CUNO

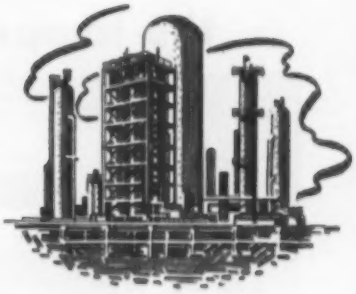
ENGINEERED FILTRATION

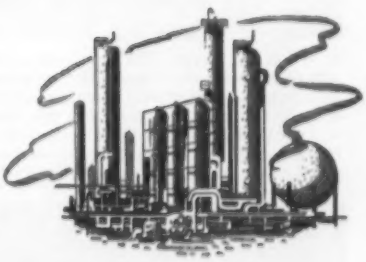
Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous metal)

HEAT EXCHANGERS

for the PETROLEUM, CHEMICAL and PROCESS Industries



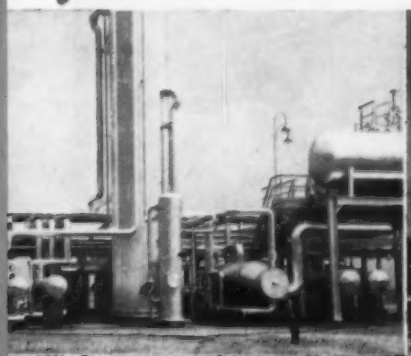


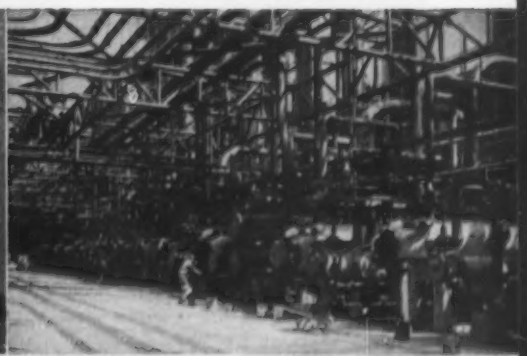
Texas Metal is engaged exclusively in the design, fabrication and repair of shell and tube heat exchangers. We are specialists in the field of custom designed heat transfer equipment for specific requirements.

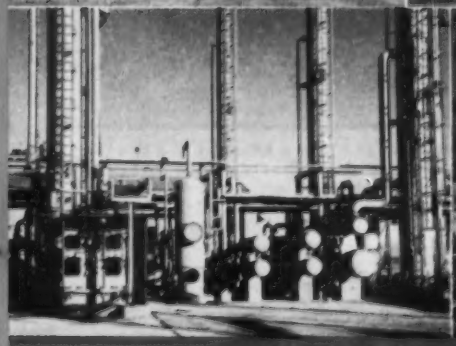
We would welcome the opportunity of quoting on your Exchanger requirements and extend a cordial invitation for Engineering Counsel on any heat transfer problems you may have. No obligation, of course.

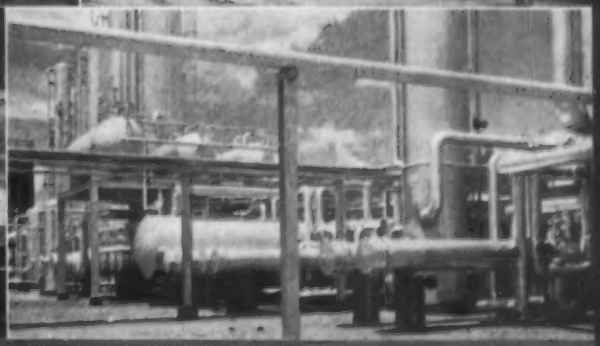
Texas METAL FABRICATING CO.

MAIL ADDRESS: P. O. BOX 7567, HOUSTON 7, TEXAS



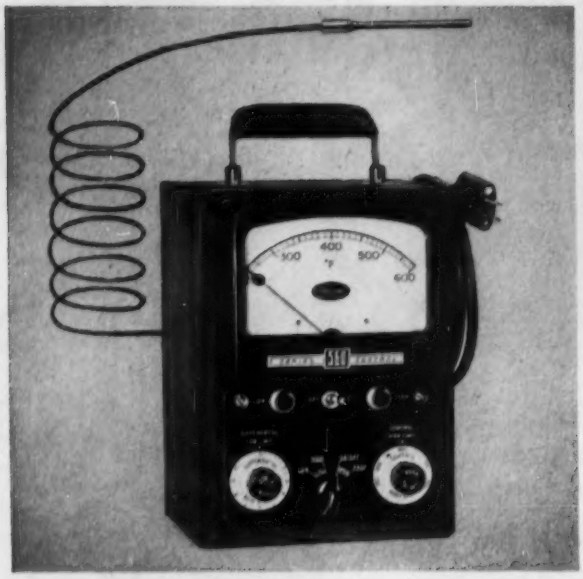






API-ASME and ASME Code Construction

Which of these two instruments provides the temperature control accuracy you need?



1. IT'S ELECTRONIC! The new Series 560 applies the thermistor principle in temperature indicator controls with heretofore unattainable accuracy over a scale range of 200° to 600°F. It's the *only* instrument that provides the three major control modes — (1) on-off (2) proportional (3) adjustable differential — all at the flip of a switch. Wide range of use for general laboratory, processing, molding or packaging applications.

2. IT'S MECHANICAL! The new Series 540 indicating controller combines low cost with high accuracy over a temperature range of 100° to 700°F. Temperature changes are transmitted by a bulb and bellows to an indicator control. Instrument features on-off control . . . adjustable differential . . . ambient compensation. May be flush or surface mounted. Capacity of 15 amps at 115 volts.

3. SIMPLICITY ITSELF is secret of Fenwal's Series 560 — accuracy, sensitivity and ruggedness. The thermistor's high resistance change permits operation with any length of lead wire up to 200 feet without affecting signal strength or accuracy. Thermistor is hermetically sealed in glass for stability; encased in stainless steel for ruggedness. No complex circuitry; maintenance is easy.

4. EASY "SET" AND "CHECK" OPERATION is a feature of Fenwal's Series 540 which is accurate to within 2% over the 100° to 700°F range, including the effects of ambient temperatures. Send for FREE NEW BULLETINS, MC122 on the Series 540, MC123 on the Series 560. Both contain full data you should have. Write to **Fenwal Incorporated, 1012 Pleasant St., Ashland, Mass.**

Fenwal Controls Temperature... *Precisely*

A Special New Product!

PRODUCED BY THE TENNESSEE CORPORATION, MINERS OF COPPER, ZINC, IRON AND SULFUR.

CUPRIC CHLORIDE

For Removal of Sulfur Compounds in Petroleum Refining.

CONTRACT REQUIREMENTS SOLICITED . . .

We are in a position to supply your needs on annual, semi-annual, or monthly contract basis — also smaller quantities in drop shipment lots.

TYPICAL ANALYSIS

Copper	37.00% Minimum
Moisture	12.00% Maximum
Fe	.04% Maximum
Zn	.01% Maximum
Water Soluble	more than 99.50%
Insoluble as copper oxychloride	less than .50%

CHECK THESE *FEATURES:*

√	HIGHER COPPER CONTENT
√	LOWER MOISTURE
√	FINER PARTICLE SIZE
√	UNIFORMITY
√	AVAILABILITY

CUPRIC CHLORIDE DI-HYDRATE
TC TENNESSEE CORPORATION

FOR

1. Quality Improvement
2. Cost Reduction

For Samples . . . Make request on your company letterhead.

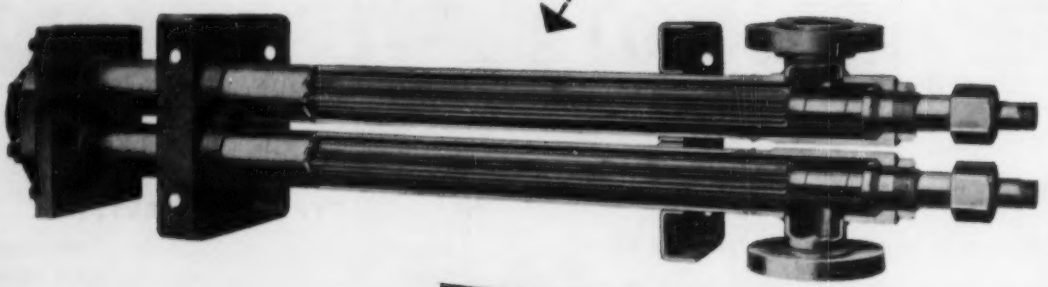
Other Tennessee Corporation products, Ferric Sulfate (Ferri-Floc), Copper Sulfate, and Sulfur-Dioxide.

TENNESSEE TC TENNESSEE CORPORATION **CORPORATION**

819 Grant Building, Atlanta, Georgia

For more data on advertised products, use Readers' Service Cards, last page.

70,000



Over 70,000 G-R Salesmen on the job!

Are seventy thousand salesmen enough to persuade you that the G-R Twin G-Fin Section is a superlative unit? Seventy thousand is the number of trouble-free G-R Twin G-Fin installations made over a period of 20 years. Some of these installations have been operating continuously for the entire period—a record unmatched in the industry.

Unmatched Simplicity:

The simplest heat exchanger on the market. *Simple design*—no tube sheets, baffles and internal joints. *Simple installation*—easily stacked and connected in series or parallel. *Simple maintenance*—no stuffing boxes, no rolled tube joints, no gaskets. Simple and effective shell end-closure.

Unmatched Versatility:

Readily converted from one service to another. Can be used for practically any condensing, cooling, heating or heat exchanger service. G-Fin elements and fins available in any ferrous or non-ferrous metal best suited to your specific applications.

THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

G-R
HEAT TRANSFER APPARATUS

Twin G-Fin Section

GR 340

REFINERY TUBING PROBLEMS SOLVED HERE

Here's a sign you can't afford to pass up. If you're in the midst of selecting refinery pipes and tubes—you'll probably welcome a helping hand. Our National Tube engineers—specialists in refinery tubing selection—are in a position to give you the help you need.

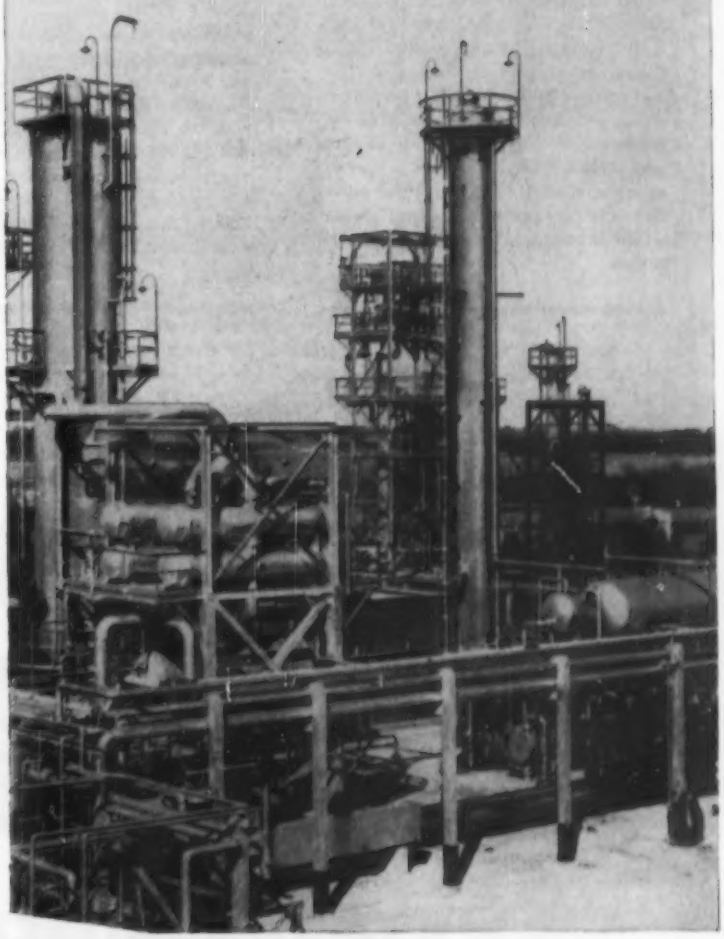
Through research and laboratory experimentation, through on-the-scene observations and extensive study of actual installations, National Tube's engineering staff has built up an "experience file"—a vast collection of case histories that dates back through 60 years of solving all manner of tubing problems. Perhaps the answer to your problem lies in this accumulation of experience.

To meet the increasingly rigorous demands of refinery service, National Pipe and Tubes have been improved constantly so that we are prepared to offer you numerous tubing analyses. Each is specifically designed to exhibit such properties as strength at elevated temperatures, oxidation resistance, and corrosion resistance. Each has been thoroughly tested under actual refinery use. Other chemical compositions are available in tubular products, and a wide variety of high temperature problems are presently under study.

We'd appreciate the chance to help you. Why not get in touch with us? No obligation, of course.

TWO DOZEN DIFFERENT NATIONAL TUBE ANALYSES:

Carbon	8 Cr, 1 Mo
Carbon, ½ Mo	9 Cr, 1 Mo
1 Cr, ½ Mo	12 Cr
1¼ Cr, ½ Mo	12 Cr, Al
2 Cr, ½ Mo	17 Cr
2¼ Cr, 1 Mo	18-8
2½ Cr, ½ Mo, ¾ Si	18-8 Ti
3 Cr, 1 Mo	18-8 Cb
5 Cr, ½ Mo	18-8 Mo
5 Cr, ½ Mo, 1½ Si	25-20
7 Cr, ½ Mo	3½ Ni
8 Cr, ½ Mo	5 Ni



NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS NATIONAL SEAMLESS PIPE AND TUBES

SEAMLESS WITHOUT WELDS

UNITED STATES STEEL

Here's why I-R CHEMICAL PUMPS always give you Better Service

They are ARMORED AGAINST CORROSION with IRCAMET

Ingersoll-Rand chemical pumps are built to stand up under the continuous handling of corrosive and abrasive liquids. All parts that come in contact with the liquid are made of IRCAMET—a high nickel-chromium-molybdenum alloy steel developed exclusively by I-R for chemical pump service. Laboratory tests and years of field experience have proved its exceptional ability to resist the corrosive action of a wide variety of acids and alkalis. Other materials are available for special conditions. The entire unit is further protected by special paint which is highly resistant to chemical action.

They are PROTECTED AGAINST LEAKAGE with the LEAKOLLECTOR

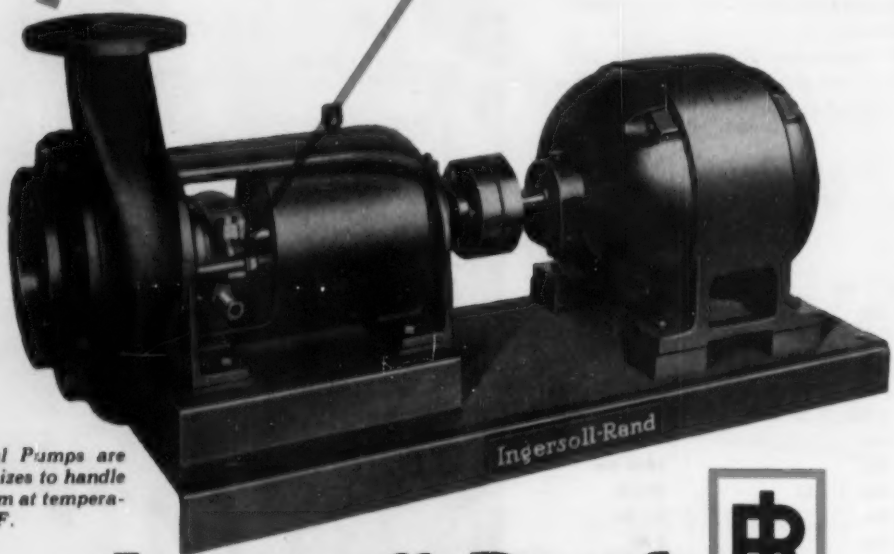
The patented LEAKOLLECTOR stuffing-box gland—an exclusive feature of all I-R chemical pumps—provides a simple and effective solution to the problem of pump leakage.

It completely encircles the stuffing box, trapping all leakage so that it can be drained away for collection or disposal. The split gland is accurately fitted to both the inside and outside of the box, and will catch any seepage escaping between the shaft and packing, or between the packing and the bore of the box. The LEAKOLLECTOR is easily removed from the shaft for repacking the box.

They are BUILT FOR EASY MAINTENANCE and LESS OF IT

These pumps are ruggedly constructed to last longer on the job—and the simple design, with all parts easily accessible, means less "time out" for maintenance. The short, rigid stainless-steel shaft prevents impeller whip and eliminates many stuffing-box troubles. The suction nozzle is removable, permitting access to the impeller without disturbing the discharge piping.

THE CAMERON MECHANICAL SHAFT SEAL can be installed on all I-R chemical pumps in place of the conventional stuffing-box. It eliminates stuffing-box leakage and rquires practically no attention or maintenance.



I-R Chemical Pumps are available in sizes to handle up to 4000 gpm at temperatures to 800° F.

Ingersoll-Rand

10-205 Cameron Pump Division
11 Broadway, New York 4, N. Y.

PUMPS • CONDENSERS • TURBO-BLOWERS • COMPRESSORS • AIR & ELECTRIC TOOLS • ROCK DRILLS

Welded-In Tubes in High Pressure Service... 7 years without a failure

One of the greatest problems in operating high pressure feedwater heaters in modern super-pressure power plants is failure of expanded tube joints. In 1947, Lummus pioneered the field in *welding* monel tubes to steel tube sheets in feedwater heaters. Two such units were built for the city of Lansing, Michigan, designed for 1200 psi. These units have had no failures in seven years of operation.

Lummus now has developed a procedure of welding copper nickel tubes to steel tube sheets. Subjected to terrific pressure and temperature tests, the welded units have gone through many cycles with excellent results. Lummus has also made one installation, in service now for over six months without a failure, having a design pressure of 2900 psi, and requiring over 30,000 70-30 cupro nickel tubes welded into steel tube sheets.

The unit shown above, with a design pressure of 2,600 psi, is being fitted with 70-30 cupro nickel tubes. Successful installations have also been made with 80-20 cupro nickel tubes.

Welding-in of tubes eliminates the possibility of tube joint failure because of fabricating inaccuracies, tube irregularities, nickel oxide deposits from annealing operations, and excessive tube hardness. Welding-in makes possible the use of heavy wall tubes which cannot be satisfactorily expanded.

Your inquiries are invited.

THE LUMMUS COMPANY, Heat Exchanger Division: 385 Madison Avenue, New York 17, N. Y.
Atlanta • Boston • Chicago • Rock Island • Cincinnati
Detroit • Houston • Tucson • Tulsa • Salt Lake City
Minneapolis • Pittsburgh • Rochester • Albany
St. Louis • San Francisco • Wayne (Phila.) • Athens
Buenos Aires • Honolulu • London • Manila • Toronto
Paris • Rome • Lima • San Juan, P. R. • Mexico City
Fabricated Piping Division Plant at East Chicago, Ind.

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

LUMMUS

THE LUMMUS COMPANY HEAT EXCHANGER DIVISION, 385 MADISON AVE., NEW YORK 17, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

VALVES AND FITTINGS

. . . SINCE 1842!

The Amazing Facts About
WALWORTH

The 1840's were eventful years. From Washington to Baltimore Morse sent his first message: "What hath God wrought!" In that decade we found the Antarctic Continent, opened the Naval Academy in Annapolis, declared war on Mexico, sold the first adhesive postage stamps, discovered gold in California. And in 1842 WALWORTH, now the oldest manufacturer of valves and fittings in the United States, set up business in the heart of Boston.

WALWORTH is a bright pattern in the fabric of American industry. To engineers in oil and gas, and to men in these industries who buy for replacement, WALWORTH on valves and fittings is as standard as Sterling on silver.

The amazing range of types, sizes and materials in the WALWORTH line never fails to delight men who know and must depend on valves and fittings in the presence of endless products, pressures, and temperatures. The line is so diversified and so ingenious that many of the machines used to manufacture WALWORTH products must be designed and built by the Walworth Company.

To specify WALWORTH is to tap the mother lode of knowledge and experience in Valves and Fittings.

MALLEABLE FITTINGS
Steel Ball Bearing Lubricated Plug Valve
Iron Body Swing Check Valve
WALWORTH
Cast Steel Gate Valve
Through-port Type 49 Steel Pipe Line Gate Valve

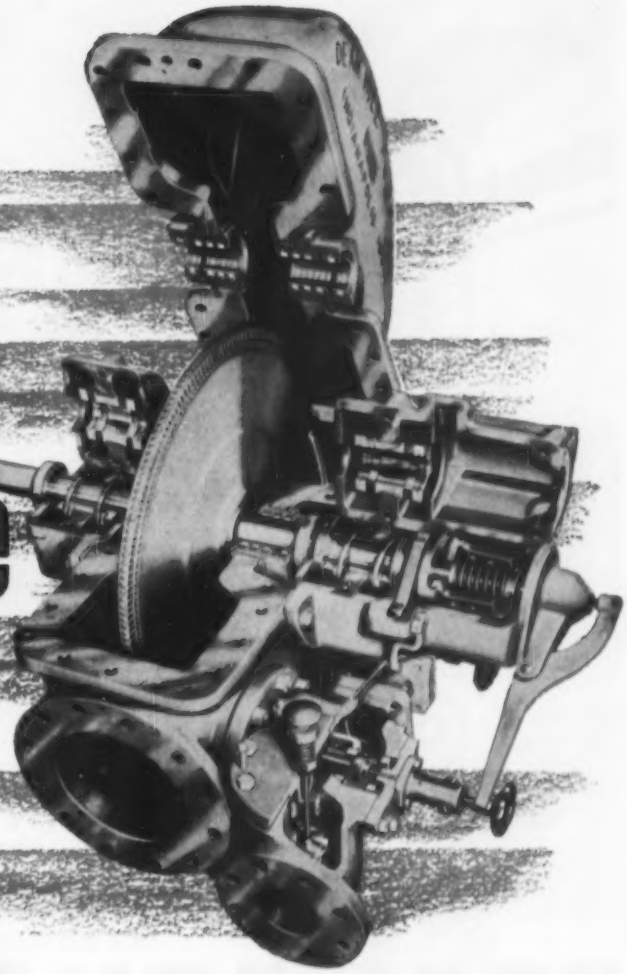
J&L STEEL

Jones & Laughlin
STEEL CORPORATION
SUPPLY DIVISION—TULSA, OKLAHOMA
Serving The United States and Canada

117-G

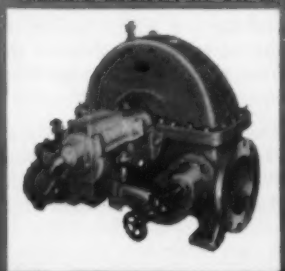
For more data on advertised products, use Readers' Service Cards, last page.

up to 100% more power



added to DH turbines

More power from the same size unit! Dean Hill presents an improved DH Line of horizontal turbines which produce up to twice the power of former counterparts.



The major change contributing to this tremendous power increase is the addition of one or more steam nozzles to all models, with these results . . .

1. The new, two-nozzle DH-10 and DH-20 turbines have *double* the maximum horsepower of former units.

2. Models DH-30, DH-40 and DH-45, now with three nozzles, are rated 50% higher in maximum horsepower.

FULL INFORMATION AVAILABLE

Many other improvements have been made on the five DH Models, adding to the quality and performance of Dean Hill Horizontal Turbines. A new catalog completely describes these models, and this information will be sent you on request.

Write Today For Dean Hill's New Turbine Catalog No. 500.

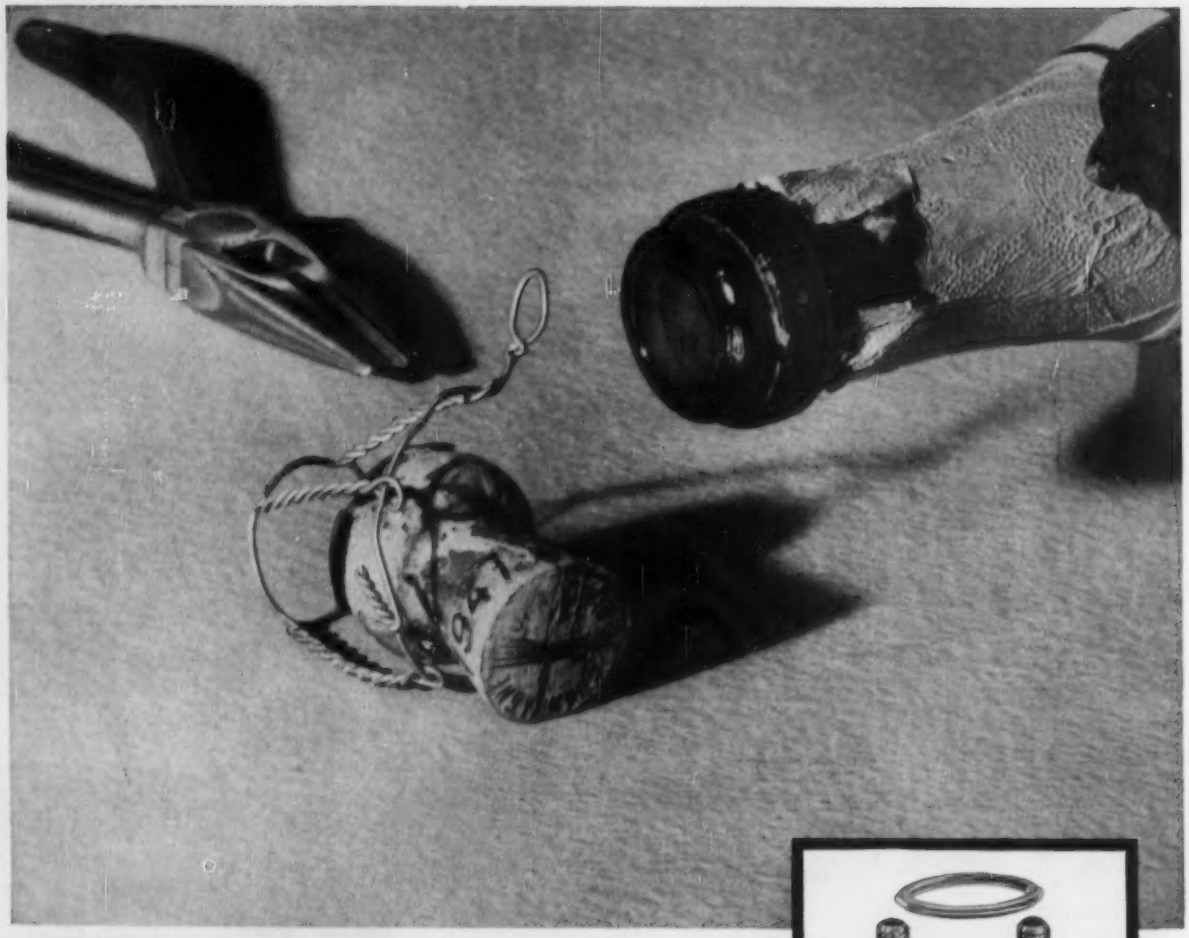
DEAN DH HILL PUMP COMPANY

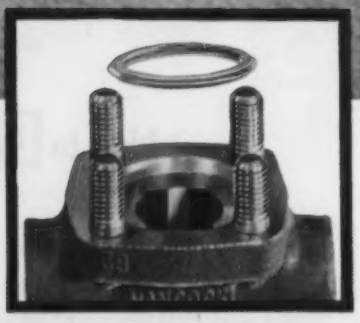
Pump and Turbine Engineers Since 1893

Indianapolis 7, Indiana

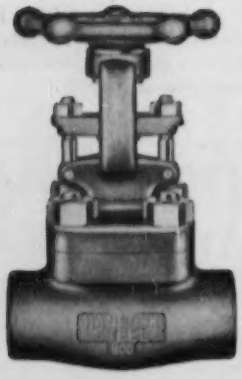
Sales Offices in:

Chicago, New York, San Francisco, Boston, Cincinnati, Denver, Albuquerque, El Paso, Salt Lake City, New Orleans, Philadelphia, Tulsa, Los Angeles, Pittsburgh, Houston, Dallas, St. Paul, Toledo, Cleveland, Grand Rapids, Birmingham, Ala., Louisville, Memphis, Nashville, Richmond, Bogota, Col., Mexico City, Montreal, Reading, Pa., The Hague





SEAL-ABILITY
that prevents blowouts



THE FLEXITALLIC GASKET creates a positive, pressure-tight seal in the bonnet joint of the Type 950 Hancock Steel Gate Valve. It is a spiral-wound ribbon of stainless steel with asbestos filler and spring-like compressibility. The gasket can be reused – cannot be flattened as the flanges which retain it form an integral compression gauge. Because the gasket rests in a groove in the body flange, it cannot blow out *even if pressures exceed ten times the rating of the valve.*

Only a specially-designed bonnet joint can fully utilize the tremendous sealing power of the Flexitallic gasket. And, only Type 950 Hancock Steel Gate Valves have Flexitallic gaskets. Advanced engineering proves that an investment in quality pays dividends in trouble-free performance. Let your nearby Industrial Supply Distributor explain fully. Phone him today.

HANCOCK VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Watertown 72, Massachusetts

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

top Cat on cracking efficiency!

Aerocat Triple A*

high alumina catalyst

balanced with HI PV*

Both high pore volume and high alumina content—that's what AEROCAT TRIPLE A High Alumina Catalyst offers refiners. This combination boosts cracking efficiency through

higher initial activity
higher thermal and steam stability
lower stack losses
excellent selectivity

In AEROCAT TRIPLE A High Alumina Catalyst, Cyanamid has carefully balanced high pore volume with pore diameter and specific surface. The result is higher activity maintenance than is possible with low pore diameter high alumina catalysts.

AEROCAT TRIPLE A is the product of a 7-year research program at Cyanamid. Commercial experience in 24 units has yielded precise determinations of its cracking efficiency and product distribution in equilibrium. It's a proved and tested catalyst!

Your Cyanamid representative will be glad to tell you what AEROCAT TRIPLE A High Alumina Catalyst with HI PV can do for your operation. Call him today.

**Trade-mark*

AMERICAN Cyanamid COMPANY

REFINERY CHEMICALS DEPARTMENT

30 Rockefeller Plaza • New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

For more data on advertised products, use Readers' Service Cards, last page.

Performance-- Value...

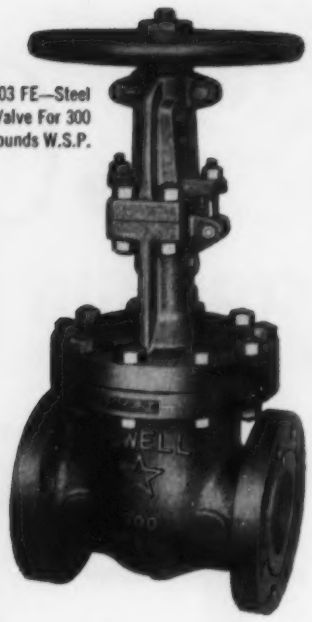


FIG. 3003 FE—Steel Gate Valve For 300 Pounds W.S.P.

FIG. 1561—150-Pound Steel Swing Check Valve.

. . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . .

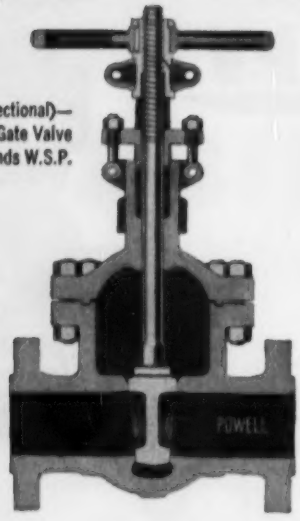
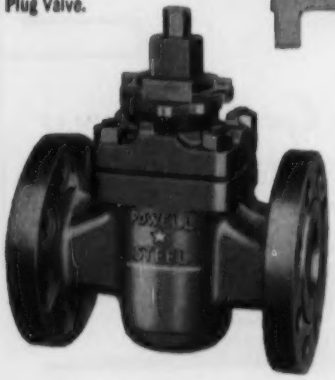


FIG. 6003 SS (Sectional)—Alloy Steel Gate Valve For 600 Pounds W.S.P.

Powell Valves

FIG. 1559—150-Pound Steel Lubricated Plug Valve.



You can depend on outstanding *performance* from every valve made by The Wm. Powell Company, for Powell Valves have a proven record of long life and dependable service.

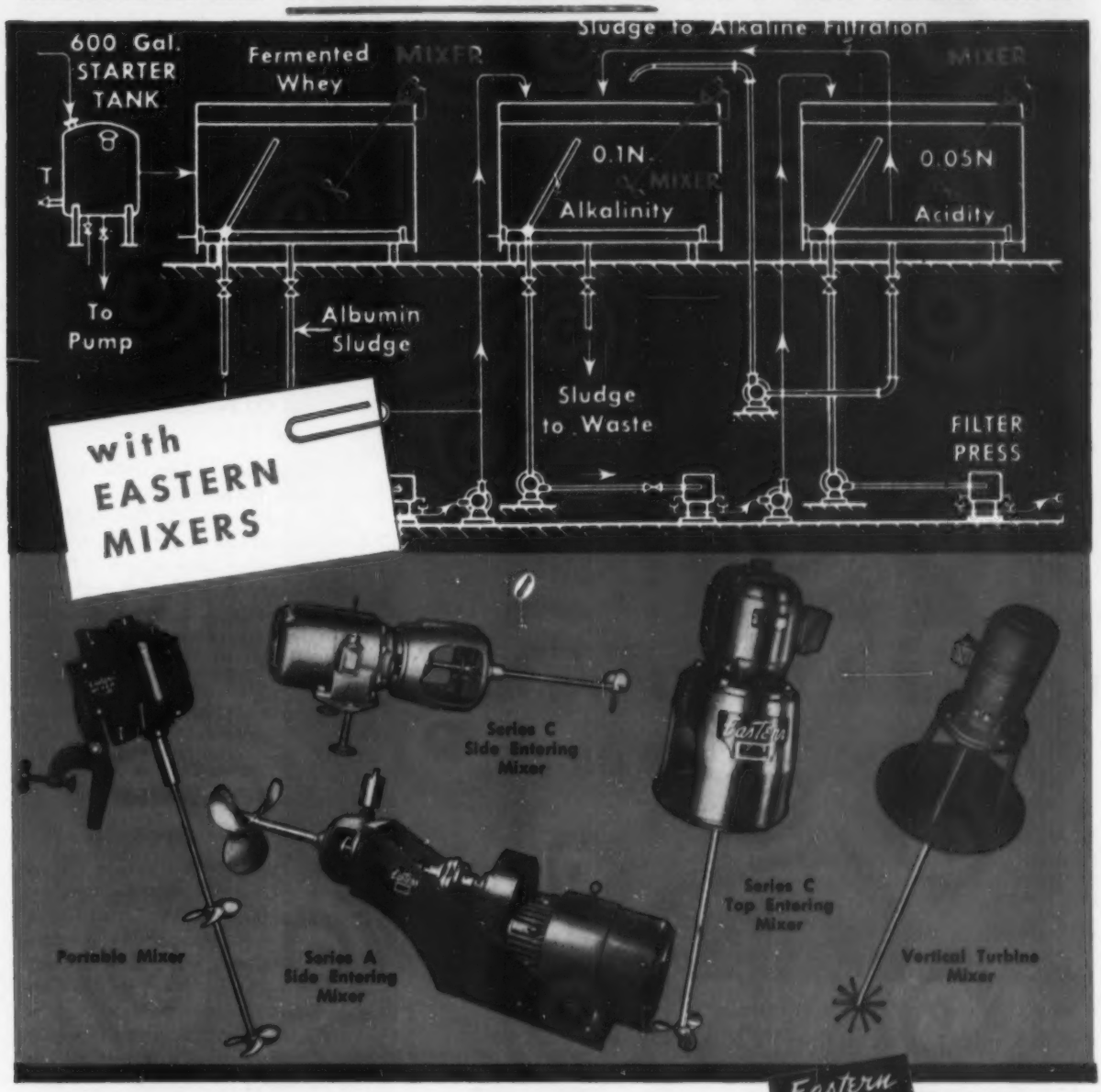
And Powell Valves give you better *value!* They're precision made and incorporate many quality features—features that can save you money and give you lasting flow control.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our *COMPLETE quality line*, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

For more data on advertised products, use Readers' Service Cards, last page.

RELIABLE FLUID MIXING in PROCESSING



Eastern's Mixers are designed to meet the needs of today's chemical and industrial processes. Many types are available to satisfy all conditions of fluid consistencies and tank sizes. Selection may be made from a wide range of horsepower, speed, and construction materials. Motors with various voltage ratings and enclosures are also furnished.

PORTABLE MIXERS

Series H at 1725 R.P.M., Series S at 1125 R.P.M., and Series G at 420 R.P.M. are available in motor ratings from 1/20 to 5 H.P. Also available are special speeds, variable speeds, as well as air driven models.

TOP AND SIDE ENTERING

Series A, extra heavy duty for large tanks, are available in side entering units only within a range of 5-30 H.P. with standard speeds of 280, 420, and 1150 R.P.M.

Series C, for average tank capacities, are available in sizes of ¼ to 10 H.P. at these standard speeds: 1725 R.P.M. (up to 5 H.P.); 1140 R.P.M. (up to 10 H.P.); 420 R.P.M. (up to 7½ H.P.); 280 R.P.M. (up to 5 H.P.). Available in both horizontal and vertical models.

TURBINE MIXERS

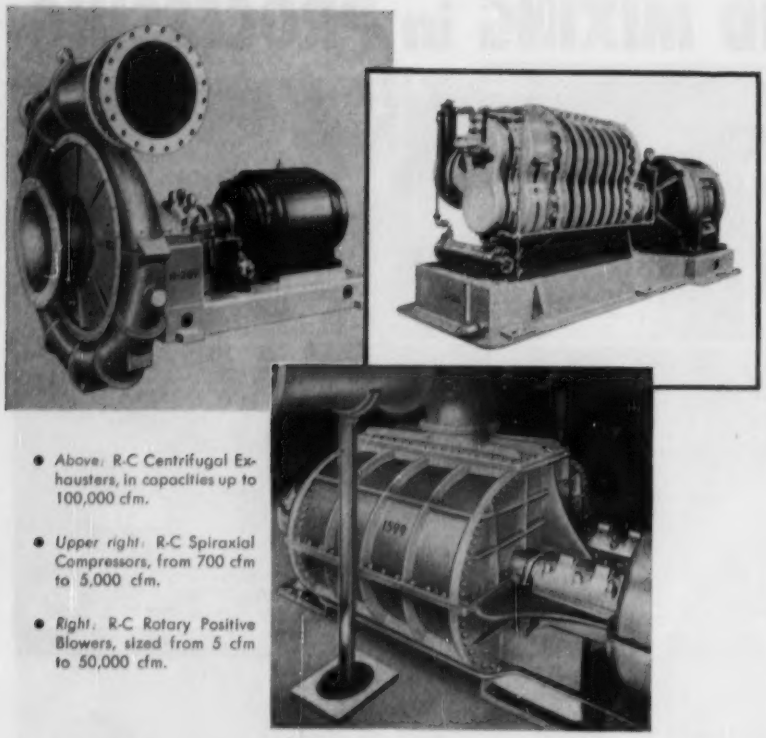
Eastern's Top and Bottom Entering Turbine Mixers find particular application where liquid blending requires gentle, yet thorough agitation.

Models are available in sizes from ¼ to 40 H.P. Standard speeds are 56, 68, 84, 100, 125, 155 R.P.M.

For 3 bulletins covering Eastern Mixers, request Catalog Series 28.

Eastern INDUSTRIES, INC.
Mixer Division
Regent St., Norwalk, Conn.

For more data on advertised products, use Readers' Service Cards, last page.



- *Above:* R-C Centrifugal Exhausters, in capacities up to 100,000 cfm.
- *Upper right:* R-C Spiraxial Compressors, from 700 cfm to 5,000 cfm.
- *Right:* R-C Rotary Positive Blowers, sized from 5 cfm to 50,000 cfm.

R-C *plur-ability* PAYS DIVIDENDS WHEN MOVING AIR OR GAS

Where quantity and quality of production depend upon the reliable, economical performance of blowers, exhausters and related equipment, look to the values of *R-C plur-ability.*

- choice of centrifugal, rotary positive and Spiraxial® types, an exclusive advantage of Roots-Connersville.
- accurate control of volume and pressure.
- ample choice of capacities, from 5 cfm to 100,000 cfm.
- high efficiencies and low operating costs.
- low down-time and maintenance expense.
- long-time durability.

All these factors add up to *R-C plur-ability.* They work for you in machines which you buy for your own use, or for resale with your equipment, where handling gas or air at moderate pressures is required. Our engineering experience and ability are at your service.

You'll find R-C plur-ability in all these products

Centrifugal and Rotary Positive Blowers, Gas Pumps and Exhausters

• • •

Spiraxial® Compressors

• • •

Positive Displacement Vacuum Pumps and Meters

• • •

Inert Gas Generators

• • •

Whether you use or sell equipment using gas or air at moderate pressures, check *R-C plur-ability.*

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

1255 Crescent Ave., Connersville, Indiana. In Canada—629 Adelaide St. W, Toronto, Ont.

The Mail Box . . .

About Our Handbook . . .

To The Editor:

I am a new subscriber to PETROLEUM REFINER and have greatly enjoyed the few issues I have already received. I recently ran across a 1952 issue of your Process Handbook edition. I would greatly appreciate your sending me your latest Process Issue as soon as possible as I'm sure it's the finest survey of petroleum processing I have ever seen.

Richard De Veirman
Technical Service Dept.
Universal Oil Products Co.
Des Plains, Ill.

Editor's Note: *The 1954 Process Handbook has been sent.*

Our next issue of the Process Handbook is scheduled for September, 1956. This December issue offers a Petrochemical Handbook which will compare favorably with the one, which two years ago, won Industrial Marketing's award for the best single issue by an industrial magazine. Its presentation of petrochemical processes is as complete as can be found in periodical form.

Fatigue Failure Query

To The Editor:

After reading the article, "How Corrosion Causes Fatigue Failures" by Messrs. Dudley and McKetta of your staff, we were struck with the reference to ultrasonic inspection captioning Figure No. 2. Could we have an elaboration on this reference to indicate the manner and purpose to which the ultrasonic technique was put in this particular application?

Specifically, we would like to know whether ultrasonic vibrations were used to directly disclose pitting or was it instrumental in removing corrosion products with pits showing up in subsequent visual examination?

Charles George
Research Engineer
W. H. & L. D. Betz
Philadelphia

And the Answer

Transverse or longitudinal cracks in small bars can be detected by ultrasonic methods. A piezoelectric crystal is brought into contact with the end of the bar and is caused to transmit

★ *new controlled volume pump*

Milton Roy Motor-Driven Pump with Instrument Air Stroke Length Adjustment. Control cabinet (front) houses components of the stroke-adjusting servo system. Remote capacity control by two process variables is possible when variable speed motor driver is used with pump.

BE SURE TO SEE IT
at the Milton Roy exhibit, "25th Exposition of the Chemical Industries," Dec. 5-9, Convention Hall, Philadelphia, *Booth 313.*

DESIGN FEATURES

Instrument air	3-15 psi
Main supply air	80 psi
Air consumption:	
Motor running full speed	15 cfm
Motor not running	0.3-0.4 cfm
Motor revolutions per inch change of pump stroke	240
Air consumption per inch change of pump stroke	2.5 cu. ft.
Stroke positioning speed	10 sec./in.
Positioning accuracy	better than 1%
Sensitivity	1/70 psi change in instrument air signal

HERE is precision controlled volume pumping with a *plus:* automatic capacity control by standard 3 to 15 psi instrument air signal. Plunger stroke length is infinitely adjustable from zero to 100% of maximum by an air-operated servo system that is accurate to within 1%. A change in instrument air signal as small as 1/70 psi repositions the plunger stroke length setting.

Heart of this new motor-driven pump is a small, powerful rotary air motor coupled to the stroke-changing mechanism. Air volume boosters in the air motor lines give fast, positive positioning. An extremely stable feedback circuit gives high positioning accuracy. Air consumption, when the system is in balance, is low — only 0.3 to 0.4 cfm.

***new bulletin* 955** gives full details. Send for your copy today . . . to Milton Roy Company, *Manufacturing Engineers*, 1300 E. Mermaid Lane, Phila. 18, Pa.

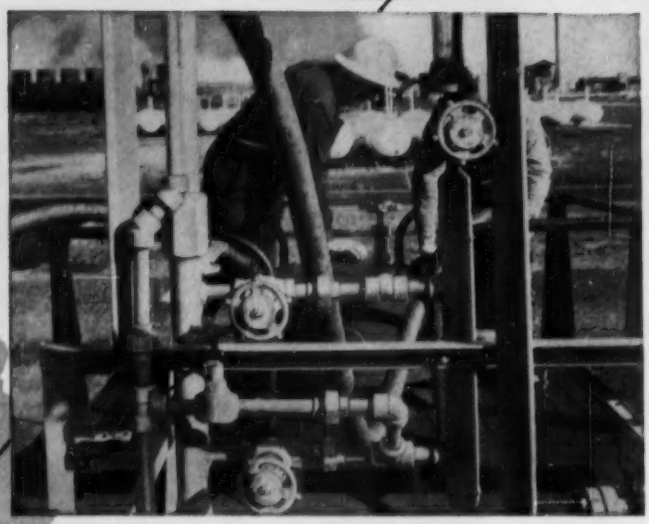
milton Roy
CONTROLLED VOLUME PUMPS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

For more data on advertised products, use Readers' Service Cards, last page.

WATSON-STILLMAN

FORGED STEEL FITTINGS



WORK BEST...under pressure

■ In high pressure steam lines...process liquid and gas piping...hydraulic fluid lines...wherever strong, tough pipe joints are needed, Watson Stillman Forged Steel Fittings provide a safety factor against costly piping failures. They resist pressure, heat, corrosion, shock and vibration because they're drop-forged of high quality steel to produce a dense, tough, forged-fiber structure that can really take it.

Extra strength is built into W-S fittings in other ways too...such as the heavy reinforcing bands extending well beyond the threads or sockets.

Protect your high pressure piping system with Watson-Stillman Forged Steel Fittings. Available in carbon, stainless and alloy steels, in Screw-End and Socket-Welding Types to meet your service requirements. Send today for Free Catalogs.

Bulletin A3-50—Forged Steel Fittings
Bulletin S-1-55—Stainless and Alloy Fittings
Bulletin U-1—Forged Steel Unions
Bulletin S-3-55—150 lb. Stainless Fittings

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WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

13

The Mail Box . . .

for several micro seconds and to receive for an equal period. The received signal is amplified and observed on an oscilloscope. The head containing the crystal may be designed so as to transmit either parallel or at 45 degrees to the axis of the bar.

Ultrasonic cleaning to remove corrosion products was not employed.

The purpose of this photograph was to illustrate how corrosion fatigue cracks can originate from pits. Upon rechecking our information, it develops that an instrument employing both sonic vibration and magnetic analysis was employed in this particular case.

No Longer An Outcast!

To The Editor:

We wish to commend Lewis F. Hatch on his comprehensive story on "Acids and Anhydrides from Petroleum,, which appeared in the October issue of PETROLEUM REFINER.

It is our feeling, however, that one or two points covered by Dr. Hatch could stand a little clarification or further amplification.

Oronite Chemical Company has been marketing since 1945 phthalic anhydride derived by oxidation of orthoxylene. The process used is one developed by our research affiliate, California Research Corporation, and so far as we know, this operation is still unique. We are proud of our pioneering position in this development and are somewhat concerned by the implication in Dr. Hatch's article that this process is one in general use.

Of even greater concern to us at the moment is the reference to metaxylene as the "orphan of the xylene family." Perhaps we have been guilty of hiding our light under a bushel. We and our research affiliate, both subsidiaries of Standard of California, have been working actively on the metaxylene problem for more than eight years. Our work has been fruitful and we wish publicly to deny that meta is an orphan and to claim parenthood of the unclaimed child, isophthalic acid.

Nearing completion now at Standard of California's Richmond, California, refinery is a new plant which will produce 50 million pounds per year of isophthalic. The product will be marketed under the name "Oronite Isophthalic" and will be available nationwide before the end of this year.

Our customers have indeed found the field of end use utilizations a pregnant one. Our product will find its way into surface coatings as a component of new and superior alkyd resins. Also soon on the market will be new unsaturated polyester resins, based on Oronite Isophthalic, of impressively superior properties. Other end use applications will become apparent as our customers bring their derivatives along to marketing stages.

R. I. Stirton
Oronite Chemical Company
San Francisco

Editor's Note: We're real happy to hear that the infant is growing up to be a respected member of the dicarboxylic acid community!

For more data on advertised products, use Readers' Service Cards, last page.

These are our contributions to tomorrow's better oil additives

The day is not far off when *Very Heavy Duty* lube oils will be needed to provide optimum efficiency in engine oiling systems. Better barium compounds will provide their extra measures of protection to detergent additives.

To be prepared for this day, we have . . .

1. Substantially increased our reserves of barytes.
2. Doubled our electric-furnace capacity.
3. Developed flake Barium Octahydrate and Barium Pentahydrate . . . advanced forms of soluble barium values.
4. Initiated bulk shipment of barium alkalis in covered hopper cars to serve large additive users.
5. Pioneered production of dense, crystalline electric-furnace barium oxide.
6. Piloted an advanced barium-oxide process developed by Westvaco engineers.

When better barium-based additives are needed, still better barium compounds will be available from Westvaco.

If you are working with lube oil additives, we would like to send you a copy of the new 24-page booklet giving complete information on WESTVACO Barium Chemicals.

AMERICA'S OLDEST AND LARGEST PRODUCER OF

BARIUM

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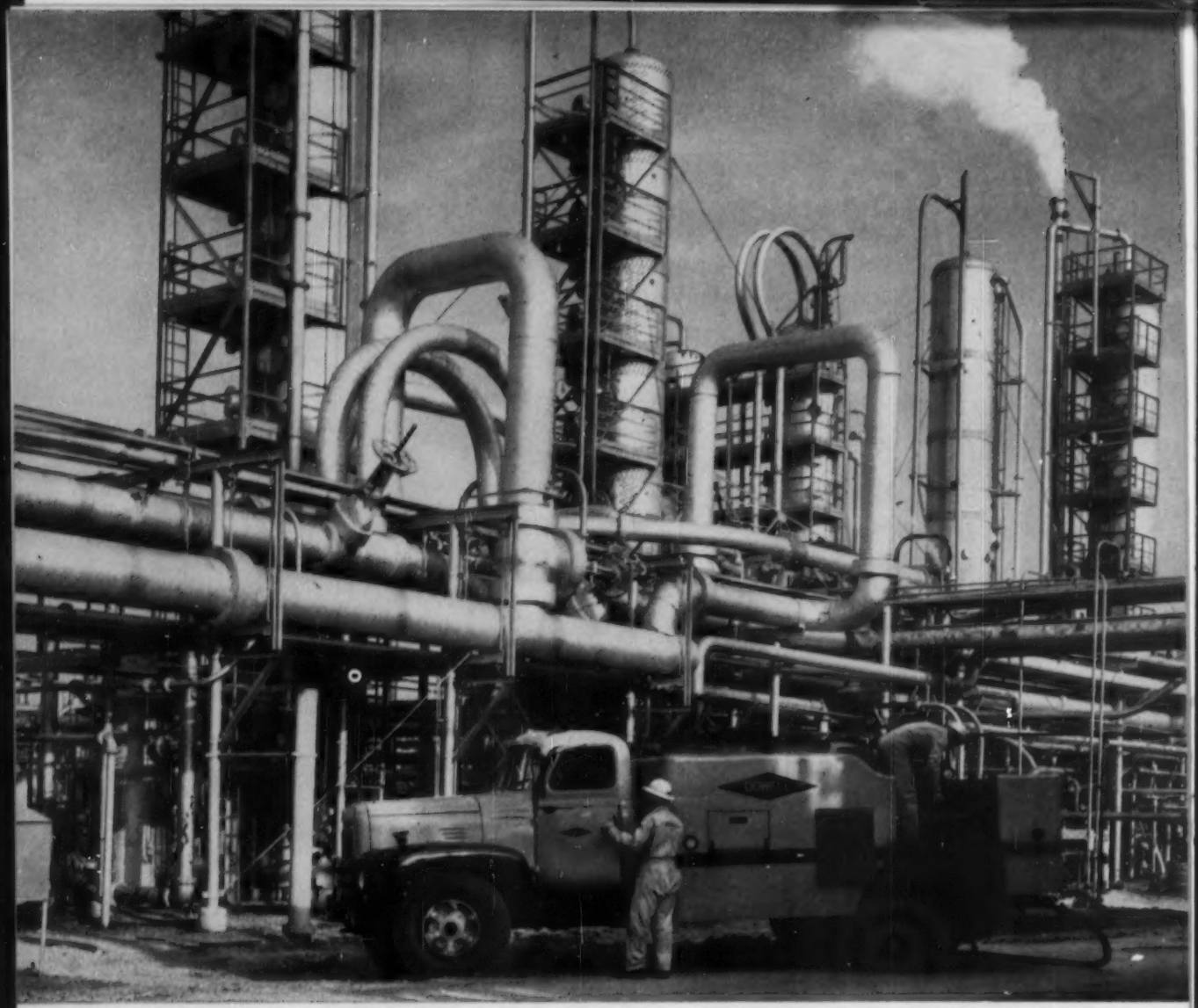

SIX DAYS OF DOWNTIME SAVED

Refinery tower cleaned chemically by Dowell in only eight hours . . . a six-day saving over mechanical methods!

A refinery operator had to shut down his H_2S stripper bubble cap tower every two months to remove an oily carbonate scale. Each shutdown took seven days, because of the mechanical cleaning methods used, and even then the tower was not thoroughly cleaned.

Dowell engineers were asked to tackle the problem. They cleaned the tower in just eight hours, using chemical solvents. Visual inspection showed the tower to be free of scale with all loose deposits washed from the caps and trays. The operator of this refinery was so impressed that he adopted a regular schedule of Dowell chemical cleaning.

Dowell chemical cleaning methods are designed to reduce costly downtime, because solvents are introduced through regular connections, keeping dismantling at a minimum. Liquid solvents can go wherever gases or condensates flow —to clean angles, bends and other irregular surfaces inaccessible to mechanical methods.

You can help to maintain maximum operating efficiency in your plant by arranging for a regular program of Dowell chemical cleaning. For full information, call your nearest Dowell office, or write Dowell Incorporated, Tulsa 1, Oklahoma, Department **L-31.**

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

A Quick Look at the Industry THIS MONTH

Petroleum REFINER
December, 1955

'56 will be an interesting year to watch. Business trend will inch its way upward, with a better over-all average than '55. However, consumer demand may taper off later in year.

—•—

Monotonous history of national deficits may take turn for better. Administration officials expect current $50 million a week spending spree to look better on the books as '56 progresses. Result: Balanced budget—or nearly so. Talk of reduced federal taxes may then turn to action.

National debt will top $278 billion by end of '55—more than $7000 for each American family.

—•—

Two major fuels of the future may soon work together to produce cheaper petroleum products. Esso announces it has used atomic energy to refine gasoline. Crude was successfully exposed to gamma radiation from 13-inch cobalt pipe on experimental, small scale basis. Next step: Tests in large pilot plants producing 100 barrels of oil products daily. If new tests work, tremendous changes in refining costs may be in the offing.

—•—

"Statesmen" trying to play political football with automation might well take second look. Today's 65 million jobs dispel fears that automatic machinery will boost unemployment. We are now enjoying highest level of instrumentation in history—and it has actually increased both jobs and pay. Example: The highly instrumented oil industry has 40 percent more employes than after World War II, and personal incomes are up one fifth.

—•—

Company mergers were the butt of many alarmed whispers earlier this year. The whisperers should look at merger history. There were only 400 last year and may be even less in '55. This compares with 800 in 1920 and nearly 1300 in 1929.

—•—

Purchasers, planners and schedulers for new plant construction had better keep the aspirin bottle handy. The steel picture for '56 could cause 60 to 120 day lags in material availability. This would be hard on the fellow with firm commitments.

—•—

AFL-CIO wedding this month will spark all-out membership drive. One of four major industrial targets will be 356,000 non-union chemical workers. Two hundred thousand already are in the fold. Three remaining targets are workers in offices, retail stores and textile mills.

The move to unify independent oil unions is going full force. Independents met in Chicago Dec. 2-3 to strengthen group aims. The plan was to move on later to Confederated Unions of America unification meeting.

—•—

Congratulations are in order for carriers of flammable liquids. Nearly 15 billion gallons of gas and oil were transported in 5900 flammable liquid vehicles last year—with only 16 fires in transit.

—•—

Natural gas control issue will be one of hottest items on the docket when Congress re-convens in January. Anti-gas mayors' group is mustering forces for

A Quick Look at the Industry (continued)

a legislative slugfest. Battle plans include hiring a lawyer to lead lobby fight against Harris bill and public relations expert to propogandize the group's efforts. Pro-Harris faction remains confident. They predict Senate approval to decontrol gas by greater majority than 11 to 4 vote which took it out of committee last session.

—•—

Shortage of junior executives is skidding from bad to worse. One reason is rapid expansion and growth of business. Second, inadequate training programs for young executives. It is becoming major worry in the front office and among stockholders.

—•—

Rumors about the death of fast tax write-offs are subsiding fast. The government has brought them to life again for a highly restricted list. Refining industry gets the biggest portion—about $100 million.

—•—

Progress of crusade against smog was aired in Los Angeles recently. Report: Definite strides have been made in reducing two major smog components—organic compounds and visible particles. However, work must be stepped up on third and most difficult one of all—oxides of nitrogen. This will mean strict control over airborne particles from industrial stacks, hydrocarbon and solvent losses by evaporation, and hydrocarbon emissions from internal combustion engines.

—•—

Promising market for synthetic rubber may soon make its appearance. Rubber paving, designed to eliminate rattle and jolt from railroad crossings, is getting commercial test at West Salem, Ohio. Rail officials claim rubber crossing reduces maintenance costs, provides smooth, cushioned surface for motorists.

Just as promising is development announced by architects at M.I.T. They have designed a new kind of house with walls, floors, celings and roof molded of plastic. Advantage over conventional houses: about 50 percent of cost of present home construction is labor on the site. Use of plastic may reduce cost to 15 percent.

Look for more synthetic glycerine production and less from natural sources (soap manufacture by-product and meat packing). Of total U. S. glycerine consumed (about 275 million pounds a year), nearly 50 percent is synthetic. Dow Chemical recently became a synthetic producer and Shell Chemical—the pioneer in the field—has announced expansion plans.

—•—

Efforts to unionize engineers and other technical employes are gaining momentum. Latest developments: American Federation of Technical Engineers made midsummer move to enlist technical engineering employes of Texas. Prime target: Men in firms with large engineering staffs. CIO's 160,000-member Oil, Chemical and Atomic Workers Union has set up special committee to study possibility of organizing professional employes. OCAW feels that within 10 years union membership of technical men will be so large employers will be forced to deal with them as a group.

—•—

Most of 77 U. S. oil fields opened during October were run-of-the-mill discoveries. Only future development will prove their worth. The five that looked best were: Woods Petroleum's 38-gravity producer in Grant County, Oklahoma, flowing 233 barrels in six hours; Aurora Gasoline's Harper County, Kansas, find good for 427 barrels a day; Sunray Mid-Continent's pool opener in Irion County, West Texas, flowing 324 barrels of 39-gravity oil; Arrowhead Exploration & New Drilling contributed a 283-barrel, 53-gravity oiler in Morgan County, Colorado; and the Texas gulf coast gained a 46-gravity field as Tide Water's wildcat flowed 231 barrels daily.

Case tractor platforms "safe-treaded" with Multigrip

Tractor drivers often find it necessary to stand while they maneuver. Loss of footing in such cases can result in serious injury to drivers or damage to equipment. To avoid accidents of this sort, J. I. Case Co., Racine, Wisc., uses USS Multigrip Floor Plate for foot platforms on *all* Case '400' Tractors. They know Multigrip's clean-edged, flat-topped risers give sure footing from all angles.

USS Multigrip Floor Plate is your safest bet *wherever* traction and sure footing are important. It's evenly spaced, "safe-tread" risers are real accident stoppers on steps, ramps, platforms and entire floor areas. Because Multigrip is made from tough steel, it won't chip, splinter or crack and can be formed for structural use. It is easy to clean, and it drains in *all* directions. Multigrip is available in large plates, reducing cost of installation. For safety's sake—always specify USS Multigrip Floor Plate.

Multigrip foot platforms make it safe for the driver to stand while driving any Case '400' tractor. Multigrip's evenly spaced, "safe-tread" risers assure safe footing even when wet or oily. Notice how the Multigrip plates have been bent to form a lip along the side of the foot platform.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS multigrip

FLOOR PLATE

Sold by leading distributors from coast to coast

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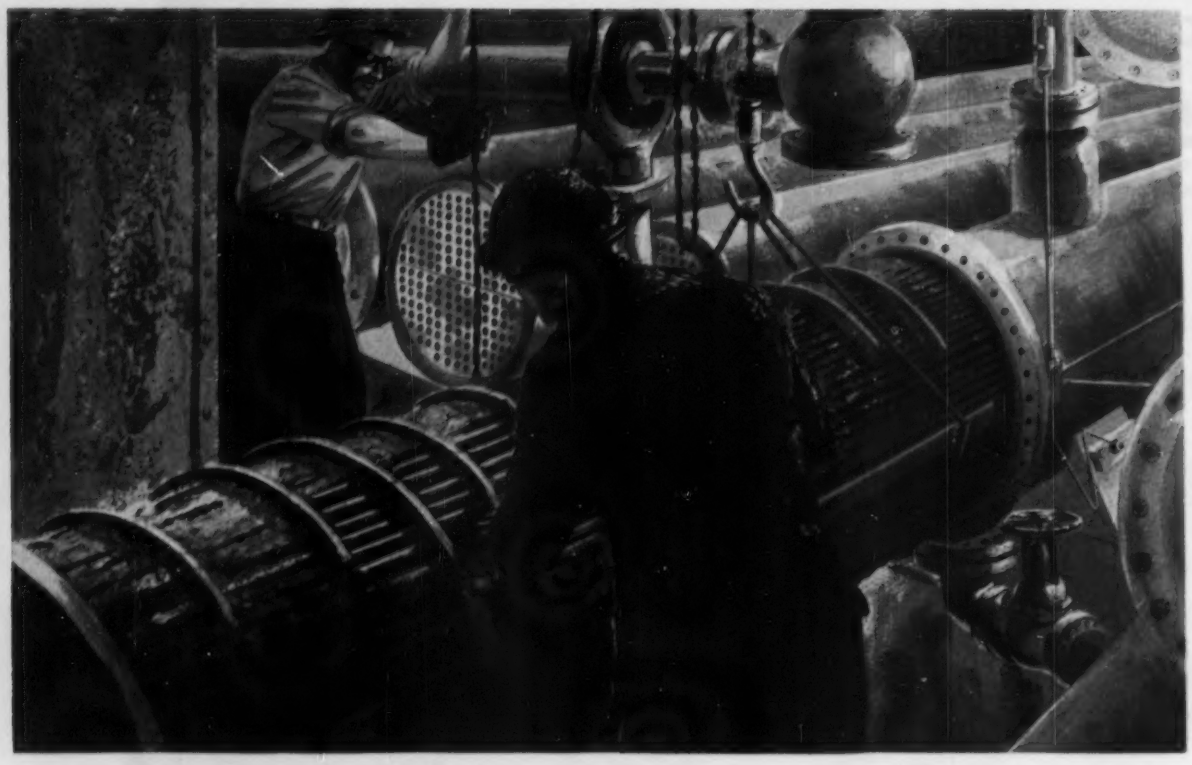
UNITED STATES STEEL



How much can you save by reducing downtime from fouled heated exchangers?

Du Pont FOA-2 can help you do the job!

Fouled heat exchangers are one of the most common causes of refinery downtime and production loss. But now, you can easily reduce many heat exchanger fouling problems with a small amount of Du Pont FOA-2. For example...

Case history

A major refinery was processing straight-run stock containing about 20% coker distillate. The initial product at 230°F. was flowing through the shell side of the heat exchanger to the pre-heater. The product at 655°F. returned to the hot receiver through the tubes.

Fouling on the shell side of the heat exchanger was so severe that it forced shutdowns every two or three days.

Du Pont FOA-2 was tried... added just prior to the heat exchangers in concentrations of 20 pounds per 1,000 barrels.

At last report, the heat exchangers had been on stream for over two months without a forced shutdown. Before the additive was used, it was not unusual to get a loss in heat transfer coefficient of as much as 10 units per day. After FOA-2 was added, there has been essentially no change in heat transfer coefficient.

Other uses

Du Pont FOA-2 can also be used as a stabilizer and sludge dispersant for diesel and heating oils. In some cases, it has demonstrated effective corrosion inhibition, too. And it can be used in combination with Du Pont Metal Deactivator which guards against metal contamination.

Whatever your processing set-up, the chances are good that Du Pont FOA-2 can help to reduce substantially your heat exchanger cleaning problems. Why not talk it over with one of our Petroleum Chemicals Division representatives. You will find him qualified to recommend the dosage and point of addition best suited to your individual needs. And you can easily get in touch with him at one of our sales offices listed below.

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... through Chemistry

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Diffusing Responsibility, a Challenging Problem

A FEW MONTHS ago, when the President of the United States was removed temporarily from the functions of the government, there was speculation as to whether adequate administration could be accomplished by the President's assistants. This situation caused us to reflect on the organizations within our own industry. Are we sufficiently diffusing the responsibility and authority of administration within our companies? Here, the need is not just for insurance against the removal of key personnel but to train employes to be more productive—to teach them that their job is more than the routine accumulation, computation, and tabulation of data.

The diffusion of responsibility is not easily achieved. The two sides to this problem are based on divergent attitudes so that it is necessary to reconcile two philosophies. To examine a particular instance where it is believed that a greater diffusion of responsibility would be helpful, let us consider the reported shortage of engineers. First let us consider management's evaluation of this particular situation. Then we will try to understand the engineer's appraisal of the same matter.

A shortage in the quality of engineers was reported in a recent survey made by the National Science Foundation. The Foundation's Scientific Manpower Bulletin No. 6 entitled, "Shortage of Scientists and Engineers in Industrial Research," has been quoted many times to emphasize a shortage of engineers. However, one of the foundation's main summaries was that half of the firms made no point of numerical shortage. These firms stated that the expansion of research and development programs are being hindered by the inability to find people with the kind and quality of training needed.

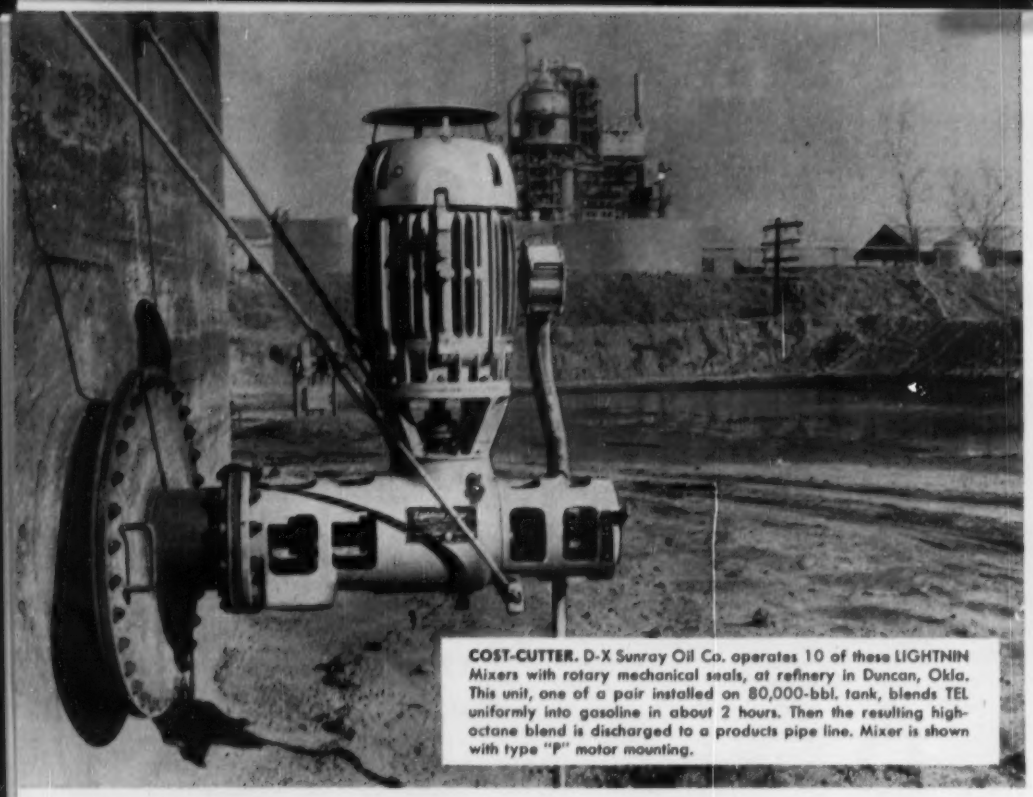
Yet a feeling of despair exists among some of the engineer employes. They state during their professional society meetings and in their articles for business papers that they have little time to show their real abilities as engineers. They contend that most of their time is taken with routine duties which leave little or no time for making proper use of the data that is accumulated and tabulated. They want to express themselves as a profession and yet their day-to-day duties seem to require that they be only technicians. There appears to be little opportunity to demonstrate their ability to solve industrial problems by the analytical processes they have learned from a formal education.

How can these two analyses of the same situation coexist? How can management say that engineers lack ability to assume responsibility while the engineers say that they are not given the opportunity to demonstrate their abilities? We believe this arises from the natural tendencies of each group. Just as it is difficult for top management to let the man of less experience and ability make decisions, it is difficult for the engineer to appreciate the value of a prompt decision as opposed to an accurate understanding. It may be that the engineers, who work doggedly on and on to accumulate more and more data before making a recommendation to management, have the same feeling that causes responsibility and authority to be concentrated in top management—fear of failure.

The results of a greater diffusion of responsibility may include a few more stumbles, but the over-all gain in efficiency should outweigh these disadvantages. Management may unburden itself of the many subordinate decisions that are required from day to day in order to carry out basic company policies. The decisions may be handled by the employes who are familiar with the information required for making them. This will give the employe a better understanding of the many factors which must be considered in order to resolve ideas, research, and operations into tangible assets. He will begin to see that detailed work must be justified in the light of the over-all goal of a given project. The engineer, who is schooled in methods of analytical and abstract thinking, will begin to grasp some of the intangible aspects of management policies.

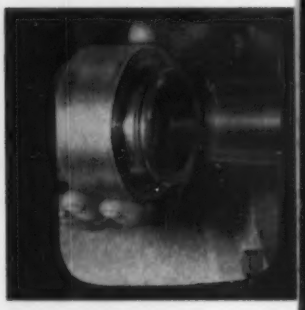
Communication is the key to a workable solution. When one goes to a medical doctor for an examination, they are in effect saying, "Doc, what do you think of the situation I'm in?" It is expected that the doctor, in the light of his knowledge and experience, will analyze the situation and recommend treatment.

When an engineer is hired by an organization, they are saying, "Sir, what do you think of the situation here?" Management has the duty to emphasize that the employe is expected to widen his experience and seek more authority. The efforts that engineers devote to acquiring more responsibility will decide whether they rise in professional stature or fall into routine.



COST-CUTTER. D-X Sunray Oil Co. operates 10 of these LIGHTNIN Mixers with rotary mechanical seals, at refinery in Duncan, Okla. This unit, one of a pair installed on 80,000-bbl. tank, blends TEL uniformly into gasoline in about 2 hours. Then the resulting high-octane blend is discharged to a products pipe line. Mixer is shown with type "P" motor mounting.

MIXER SHUTOFF closes like a valve to keep liquid in the tank while seal is being changed. No need to drain the tank. One man can replace seal in a few minutes.



CARTRIDGE SEAL slides off shaft. New seal cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

No stuffing box to repack!

How D-X Sunray Oil Co. slashes mixer upkeep with new, easy-to-replace LIGHTNIN Mechanical Seals

D-X Sunray Oil's maintenance men hardly ever touch this LIGHTNIN Side Entering Mixer.

It *never* needs repacking. There's no stuffing box to fiddle with. And there's *no leakage.*

In place of a stuffing box, this LIGHTNIN has a quickly-removable cartridge-type rotary seal. This new LIGHTNIN Seal positively stops product leakage. It runs for *years* without attention.

But if the seal ever needs to be replaced, *one man* can replace it in a few minutes. And he does it without draining the tank, without demounting or dismantling the mixer.

Does it work? Judge for yourself: after trying out two of these LIGHTNINS at its refinery in Duncan, Okla., Sunray has purchased *eight more* of the same type, for installation on new tanks.

Get solid maintenance savings

You can cut maintenance cost, and stop product drippage around your tanks, too—by specifying LIGHTNIN Mixers with the new, easy-to-replace LIGHTNIN rotary mechanical seal. Some users are saving *as much as 90%* of the time and money once spent on stuffing box upkeep.

There are other mechanical reasons, too, why LIGHTNINS are your best equipment buy for the long pull. For instance, you can't ever lose alignment of parts in a LIGHTNIN. Positive alignment is built in, for keeps, with concentric rabbet fits that mean smoother running, often for 20 years and more.

And LIGHTNINS give you extra safety with *hollow-quill power* transmission on gear drive Models SE. *Two* separate sets of heavy-duty bearings—one to carry transmission loads only, one to take the brunt of mixer shaft loads. A flexible coupling links shaft and quill, to protect gearing from *any* sudden shock or strain on the shaft.

You get your choice, too, of seals *or* stuffing boxes to fit the job—with or without positive, easy-operating tank shutoff device that permits seal change or repacking without losing a pint of product.

Your LIGHTNIN Mixer representative will be glad to give you the full story on how LIGHTNINS for *your* tanks, new or old, can help you avoid shutdowns and reduce maintenance cost. He's listed in your copy of The Refinery Catalog. Why not give him a call today?

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Many engineers get into the profession because they derive a great deal of satisfaction from understanding physical and chemical phenomena. Later, they may consider their work consists of routine functions from which they derive little benefit or development. It is then that they may realize that they have spent too much time asking themselves *how* to do a calculation or apply a principle and too little time asking *why* perform the calculation or apply the principle.

A Year-'Round Progress Week

WHAT WOULD BE the effect on you, us and the rest of the world if all petroleum research development folded up except for a single week each year?

We won't answer that one, but will ask another: Isn't that just about as sensible as thinking that public opinion favorable to the petroleum industry can be attained by an annual shot that lasts only seven of the calendar's 365 days?

A continuing program of petroleum research and development has resulted in great things for this civilization of ours. It has not only produced improved gasoline, which perhaps the world knows best, but thousands of other refined and synthetic products. A list of these, of course, would consume great space, but it includes besides gasoline, kerosine, the various lubricants and fuel oils, plus everyday products ranging from plastics and varnishes to perfumes, clothing and medicines.

Surely the petroleum industry renders a real service to virtually all peoples of the earth. So this matter of favorable public opinion is one of just getting the public to realize that here is an highly essential industry doing one heck of an efficient job.

That, of course, is the purpose of Oil Progress Week which is held every October. So this squib is being indited merely to remind those connected with the petroleum industry of something that they surely know: the job cannot be accomplished by working at it only one day each year. And we should no more consider such a program adequate than we or the world should think that adequate petroleum research can be done by devoting only 7 of 365 days yearly to the job. No matter how intensive our concentration to either task, the goals could not be attained by such a plan.

Public relations, we are reminded on every hand, is not a one-shot proposition. Like petroleum research, it must be a constant and continuing thing. With the problems which our industry faces in Washington during the coming year—and, perhaps the plural here would be more correct—we will need every bit of influence that the industry can muster. Favorable public opinion is the best second we could possibly line up to sit in our corner. So let's not let down for a moment.

Gasoline Stocks May Be Burden

THE INDUSTRY'S economic position was not helped by the high refinery operating levels of recent weeks. Refining rates were just short of peak volumes, and the result was stepped-up output of gasoline and distillate fuel oils.

Gasoline stocks rose sharply, adding to the threat that they may become burdensome by the end of next March. Heavy demand caused some improvement in the distillate inventories, but they still appear to be on the excessive side.

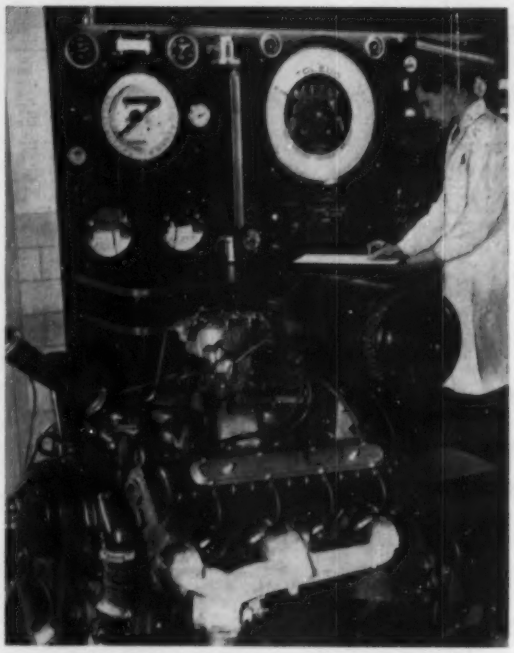
Runs to refinery stills during the first 18 days of November averaged more than 7½ million barrels daily. Highest monthly average during 1955, and considerably up from September and October levels. Consequently, production of the major products increased.

Despite the hike, gasoline stocks were the only ones to register a gain. A substantial change occurred in the relative position of motor fuel stocks with year-ago volumes. Inventories totaled 153½ million barrels on November 18, which was 6¼ million barrels more than was in tanks a year earlier, but this gain occurred in the past month for in mid-October gasoline stocks had been at the same level as the year before.

These large seasonal additions to the gasoline stockpile will continue through March, and the problem is to hold them within reasonable bounds. It is considered desirable that next March's motor fuel inventories be not more than five percent greater than 1955 volume. That would mean that they should not exceed 195 million barrels by the end of the first quarter of 1956. That leaves room for a winter build-up of about 40 million barrels, which would be only slightly greater than the 37 million added in the same period of 1954-55.

Despite large refinery production, distillate fuel stocks were lowered early in November as cold weather in many parts of the nation began to make inroads into these supplies. This improved the distillate situation, but inventories are still far ahead of last year's volumes. These stocks totaled 118⅔ milion barrels on November 18, after reaching an all-time high of 152 million earlier in the month. Mid-October found distillate stocks 15½ million barrels higher than year-before levels, but the latest inventory placed them at only 13⅓ million over last year, and the recent reduction is encouraging. However, more large drafts must be made during the next 4½ months to bring distillate down to desirable levels for the start of the build-up season.

Recently seven experimental fuel additives were tested in a fleet of passenger cars under severe conditions. Tests showed that four of the additives reduced exhaust valve life, whereas three actually increased it 25% to 50%. In another make of car, under the same conditions, not one of the additives had any effect on valve life. It's small wonder such a great amount of experimental effort goes into durability testing.



Most durability testing of new additives must be conducted in multicylinder engines. Priority is given to operation of these engines in the laboratory rather than on the road because it is easier to maintain close control of test conditions.

Engine durability testing for new additives

By R. V. KERLEY
Ethyl Corporation, Detroit, Mich.

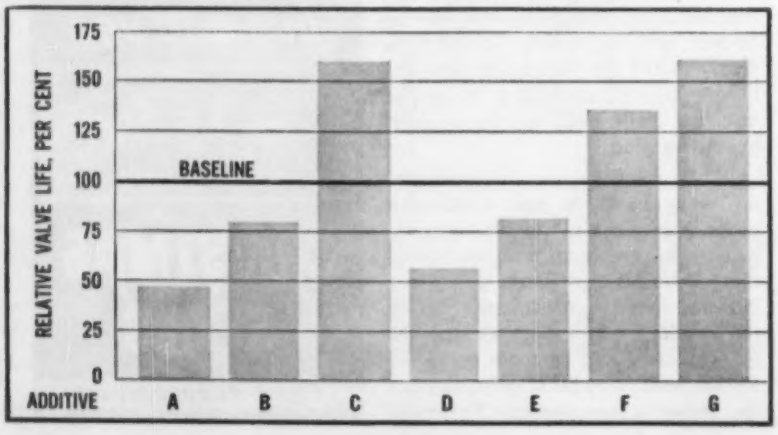
AS THE TREND to higher compression engines has continued, many additives have been developed to meet new requirements. Scavengers have been designed to increase exhaust valve life, and additives developed to inhibit rusting, to increase fuel stability, and to prevent carburetor icing. Other additives have been developed to suppress spark plug fouling and deposit-induced surface ignition. Undoubtedly, new additives will be discovered to supplement or replace many of those currently in use.

Durability testing vital

Development of any new additive requires a great deal of testing before the product can be marketed with the assurance that it will be beneficial to all users. From past experience it has been found that much of the total development effort must be spent on the durability aspects of the additive. That's because very small concentrations of different chemicals may either improve or drastically reduce engine durability as shown in Figure 1. In some cases it has been shown that as little as one gallon of additive in 50,000 gallons of fuel may reduce exhaust valve life to half of normal. On the other hand, increased amounts of the same additive may actually double normal life (Fig. 2).

Of course, a great many factors other than valve life must be considered in establishing the commercial possibilities of fuel additives. For instance, an additive's effect on engine wear, exhaust valve lash loss, combustion-chamber deposits, fuel economy, oil economy, the exhaust

FIG. 1. Effect of seven fuel additives on exhaust valve life.



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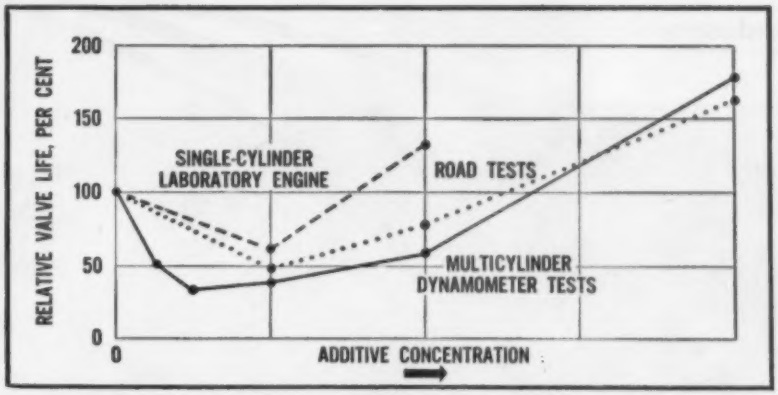

FIG. 2. Effect of full additive concentration on valve life with three different engines and different operating conditions.

system and even rear-bumper corrosion from exhaust products. If an additive registers a marked adverse effect on any of these important factors, it must be eliminated from further consideration.

Durability testing tools

Tools available for use in durability problems are generally put in the following order: (1) Chemical laboratory tests (2) Single-cylinder engine tests (3) Multicylinder engine laboratory tests (4) Fleet tests.

Chemical laboratory tests. These tests will generally supply all the needed information concerning the effect of additives on fuel storage stability, metal corrosion, and deterioration of rubber-like parts.

Single-cylinder engines. The Ethyl Corporation uses single-cylinder engines for preliminary testing of additives for positive and negative effects on valve durability. These engines permit close control of test conditions, require relatively small quantities of precious experimental materials frequently required. However, single-cylinder engines never act exactly like multicylinder engines. So the results from single-cylinder engines are regarded only as indications of durability effects until the data are substantiated by multicylinder engine tests.

Multicylinder laboratory tests. Most of the durability effort must be conducted in multicylinder engines. Therefore, in most laboratories, scheduling gives priority to operation of these engines in the laboratory rather than on the road. There are two reasons for this preference: In the lab you can maintain closer control of engine test conditions and since these tests are generally considered more reproducible, fewer tests are necessary to separate promising materials from those giving less satisfactory results.

Fleet tests. Final step in the development of the additive is to test it with vehicles on the road. This step is important for two reasons. It acts as a check on the conditions chosen in the laboratory tests and it provides results which are much more acceptable to the purchaser of the product.

Obviously, no single test or any group of tests on a single engine should be used to predict the effect of additives on engine durability. Thousands of hours of dynamometer testing and millions of miles of road performance in a wide variety of engines must be conducted before a company can be sure its new product will benefit the user. And even after extensive testing has been done, sound judgment based on experience and knowledge must be exercised.

Send for a reprint of our technical paper entitled "Fuel Additives and Engine Durability." It will give you the philosophy of durability testing, choice of test equipment and actual test schedules used. Address your request to Box 14, Ethyl Corporation, 100 Park Ave., New York, N. Y. No charge.

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How Vulnerable Are We?

Dispersal may be the answer to oversaturation of U. S. industry in certain areas.

Neil P. Hurley, S. J.,
Fordham University, New York City

FOUR H-BOMBS could wipe out almost half of all U. S. petroleum processing plants within a few seconds.

The four key target areas are Houston-Beaumont, Los Angeles, Philadelphia and San Francisco. If these cities were successfully attacked with H-bombs more than 40 percent of the nation's refining capacity would be disrupted. Forty-six percent of the petroleum chemical plants would be inactivated.

Disturbing? Yes, because the petroleum processing industry's role is vital to the nation's civilian and defense economies. In only 10 years petrochemicals will account for more than 50 percent of total U. S. chemical production. And chemical production feeds all 72 basic industries as classified by the Department of Commerce.

In our present economy regions, states, industries and productive facilities are intimately related in a web of mutual dependence. And petroleum processing companies represent a vital link in the logistical and supply chain of the U. S. mobilization program. Therefore, it is imperative that crucial industries reflect on the defense posture of their component processes and plants.

We live in the H-bomb era with a designing enemy that is rapidly strengthening its capabilities to deliver a surprise multi-target nuclear attack on America's key urban and industrial centers. Experts, such as General Hoyt Vandenberg, estimate the present kill-ratio of enemy planes at about 30 percent, leaving a sizable percentage of attack bombers and guided missles to penetrate the United States. Suppose 60 percent of a Russian air fleet of 500 bombers reached American targets, how much of a "sitting duck" would the petroleum processing industry represent? What would be the scope of nuclear damage on its productive capacity?

Vulnerability Factors—The atomic vulnerability of the petroleum processing industry, and indeed of any large-scale industry, may be viewed from three aspects:

1. Geographical concentration of its plants and productive facilities.
2. Product concentration at one or more stages of processing so that for lack of a component item later stages would be disrupted production-wise.
3. Functional interdependence among industries which if struck by nuclear weapons would produce adverse repercussions on affiliate companies and processes.

Geographic Concentration—It is an acknowledged fact that petroleum processing facilities, especially refin-

Here's an example...

The Houston area contains 5.201 percent of the total employment in the U. S. for the processing of petroleum products. This region is not considered a target zone for tax amortization purposes in the dispersal program.

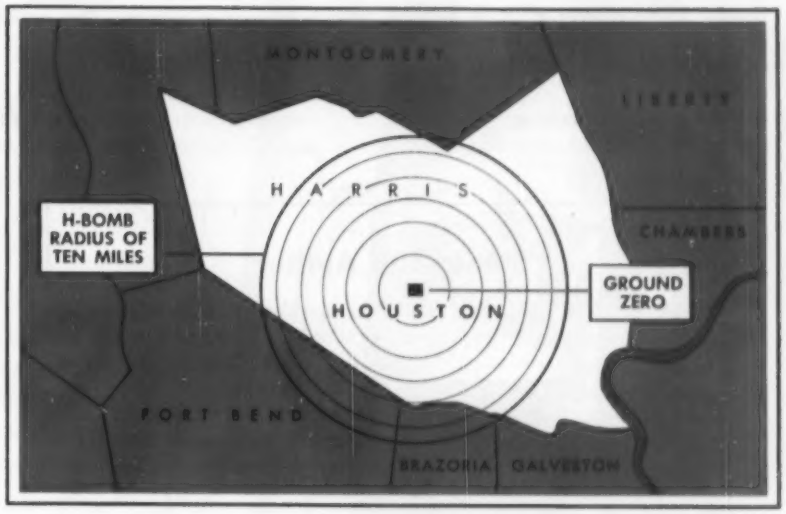

FIGURE 1

ing plants and petrochemical establishments, are concentrated in a few areas within coastal states (see Table 1). Closer examination discloses that the areas of high density are four.

TABLE 1

CITY	Petrochemical Plants		Refineries Percent of U.S. Total Capacity
	No.	Percent	
Houston, Texas	14	11.1%	7.2%
(Houston-Beaumont area)	(34)	(27.0)	(21.2)
Los Angeles, Calif.	9	7.1	8.1
Philadelphia, Pa.	8	6.3	8.1
San Francisco, Calif.	7	5.5	5.1

The maps shown here reveal the geographic concentration which is to be found in petrochemicals and petroleum refining. Figure 2 shows that petrochemical facilities are centered in the Texas Gulf Coast area and the Southern California seacoast. This corresponds with the geography of petroleum refining as Figure 3 clearly shows. The four concentrated areas listed in Table 1 are all seaboard locations, amenable to attack from sea as well as by air.

Particularly appealing as a target is the Texas West Gulf Coast area, consisting of a belt of land extending inland 100 miles along the Gulf Coast from the Texas-Louisiana boundary line to Brownsville, Texas. This area contains refining capacity of more than 1,990,000 barrels daily, representing 85.4 percent of the total Texas capacity, and 23.4 percent of the nation's total capacity. Combined investment in oil refining and chemical plants in the Gulf Coast belt is between $2.5 billion and $3 billion of which approximately one-half is within a radius of 60 miles from Houston. The Houston-Beaumont axis alone contains an estimated 50 percent of the organic petrochemical capacity of the U. S., as well as over 20 percent of the refining capacity in the nation. The entire Texas West Gulf Coast has 17 percent of the na-

FIGURE 2—Concentration of petroleum processing plants by states, excluding carbon black and sulfur.

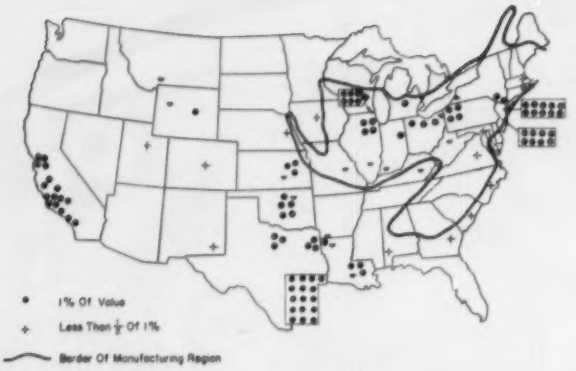

FIGURE 3—Concentration of petroleum refining facilities by states.

tion's known natural petroleum reserves and 25 percent of the known natural gas reserves. Moreover this entire region serves to provide deep-water ports for foreign and coastal shipping, and is a barge terminal for coastwise traffic and water transportation. Geography-wise it is fairly obvious that petroleum processing facilities in America have high target-rich values.

Product Concentration—In addition to being highly nucleated, petrochemical plants, oil production facilities and refineries are perhaps the most vulnerable of all manufacturing processes in the matter of blast and explosion damage. Construction for petroleum processes has little, if any, protection or shelter. These possibilities bear serious consideration in this regard:

- Principal installations such as cracking coils, distillation units and alkylation plants would be exposed to heavy and concentrated damage from nuclear attack.
- Key units, such as distillation and extraction towers, are highly susceptible to blast damage.
- Blast, radiation, thermal diffusion and radioactive fall-out are definite hazards to tanks storing inflammable materials, to sensitive instrumentation controls and feedback mechanisms, and to pipeline facilities leading to and from the processing plant.

Due to its inescapable orientation to the subterranean deposits of crude oil, gas and natural gas, and because of the fragile and exposed nature of its facilities, the petroleum processing plant is less immune to nuclear attack than any other American operation.

Functional Interdependence—Apart from the direct damage inflicted by an H-bomb attack, the petroleum processing industries could easily be paralyzed by indirection. For example damage to any of the pipe line centers would seriously affect refineries and petrochemical plants which were dependent upon them. It so happens that the key petroleum pipe line terminals are also large urban centers such as Chicago, Los Angeles, San Francisco, Toledo, Kansas City and St. Louis. Disastrous effects would most likely flow from an accurate H-bomb run on these metropolitan areas and other chief pipe line terminals as Port Arthur, Houston and Corpus Christi, Texas; Wood River, Ill., Lima, Ohio; Patoki,

See **How Vulnerable**
Continued on Page 232

Meet the Author

NEIL P. HURLEY, S. J., has been a student for the priesthood in the Jesuit order since September, 1947. He has a degree in accounting and an M. A. in political science from Fordham University. He will receive his Ph.D. in February, 1956.

Rev. Hurley's background includes work with an advertising firm that distributes phone books, a top flight accounting firm on Wall Street, and the position he resumed this fall, teaching economics at Fordham. He first came into contact with the petroleum processing industry when he became interested in the Government's tax amortization plan for industrial mobilization . . . he wanted to find out if this plan was actually effective in practice.

At first he planned to study only the automobile industry to determine whether the fast write-off incentive was having effect in scattering new defense facilities. To make his study more complete, he decided to include the chemical and petroleum processing industries, and the iron and steel makers.

During the 15 months it took Rev. Hurley to complete his survey, he contacted many top industry leaders to get their views on the feasibility of dispersal. He also went to Washington to talk to people in ODM, the Commerce Department's Business and Defense Services Administration, Industrial War College, Federal Civil Defense Administration and Department of Defense.

1955 Petrochemical Handbook

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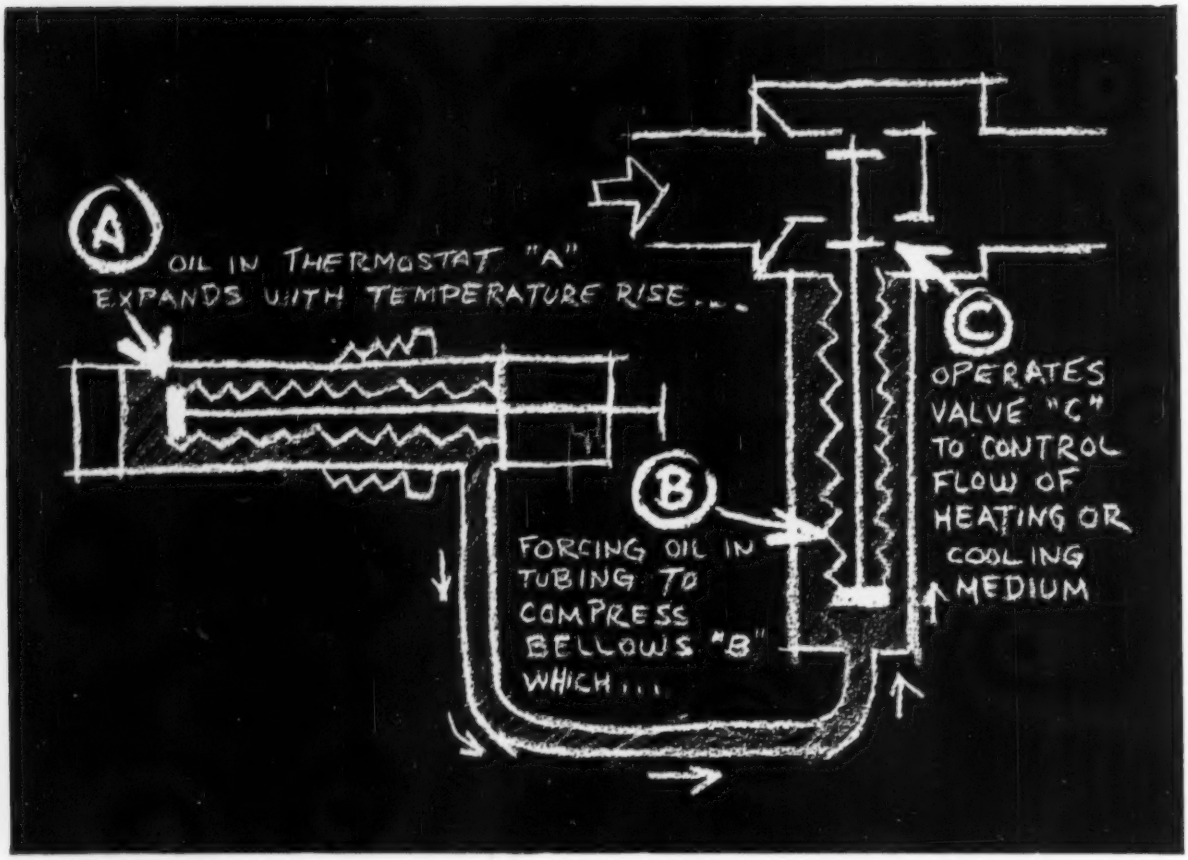
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FOREWORD

1955 Petrochemical Handbook

THIS THIRD ANNUAL PETROCHEMICAL ISSUE marks another banner edition in the REFINER's coverage of petrochemicals. This edition is unique in its presentation of the most complete handbook to petrochemical processes available today and replaces the handbook edition of 1953. Going beyond processing, this edition also presents outstanding articles on petrochemical production tomorrow, raw materials today and the boom in synthetic rubber.

The petrochemical industry has leaped from one producer of 75 tons in 1925 to more than 100 producers in 1955 who produce in excess of 28 billion pounds. Plastics have grown from nothing to an estimated 3 billion pounds in just a few short years. Synthetic fibers now account for 25 percent of the textiles consumed and they require petrochemicals in excess of 1.5 billion pounds per year.

The current production of petrochemicals makes use of only about 1 percent of the total petroleum production but this is expected to rise to 2.7 percent by 1975. The incentive: conversion of petroleum into petrochemicals increases its value approximately 12 times while conversion into fuel increases its value only 2½ times.

Most manufacturers are looking at their raw material source rather closely as this year ends. There is still not much trend to want to change raw materials. Those that are using natural gas will continue even though prices do rise a little; those using LPG are in the best position because of increased supply and the somewhat softening of price; those using refinery off-gas are making plans to expand their production using more of the same; and heavy fuel or residual fuel oils are getting quite a play by those manufacturers planning new plants in locations apart from present operations.

Petrochemical intermediates and hydrocarbon polymers look like the boom children for the coming year. Synthetic rubber holds promise of considerable activity during 1956. The article on production (Page 110) points out these interesting facts. Not all petrochemicals will have the same growth pattern during the coming year and some of them will either be stagnant or show some decline in production. These can be explained by start-up difficulty with new plants; if intermediates, the lack of demand for them in the next manufacturing step; end use market changes; and some of the newer substitutes have actually proved better than presently available materials. None of these reasons are cause for distress as the petrochemical industry has always based its programs on research and what can be invented once can always be modified and new uses found for most any petrochemical. One thing that stimulates the industry to a great extent is the competition between various products for the same end use. We are all looking for a good year in 1956.

The major basic petrochemical is still ethylene. The 1955 production of this petrochemical was in excess of 2 billion pounds. Major use is ethyl alcohol manufacture but increased production of polyethylene should soon require the major proportion.

Propylene is produced in excess of 1.5 billion pounds per year and is used

primarily in the production of isopropyl alcohol. Synthetic glycerine claims a large share of this valuable intermediate as well as phenol and acetone by way of the propylene tetramer-cumene route.

Butylenes were produced in excess of 2.2 billion pounds and this is due increase in 1956 with the synthetic rubber expansion that is coming. Further the use of butadiene as a chemical intermediate is increasing and this should cause further expansion in the production of this basic petrochemical.

Of the aromatics that go into petrochemicals benzene still holds first place. The 1955 production was more than 0.7 billion pounds. This was consumed in the further manufacture of petrochemicals and in some direct end uses. Other aromatics are consumed in the synthetic fiber industry and with the trend toward more man-made non-cellulosic fibers this trend should require added production facilities for specific aromatic petrochemicals.

The newest entrant into the field of basic petrochemicals is acetylene from natural gas. Acetylene production that finds its way into chemicals was in excess of 2 billion pounds in 1955. Of this production about 900 million pounds found its way into petrochemicals. The interesting fact here is that about 12 percent of this acetylene was manufactured from natural gas. The consumption of acetylene petrochemicals is increasing and because of the diversification of industry we look for more natural gas-acetylene plants in the coming year.

AMMONIA: In spite of the thinking last year that ammonia had just about reached its peak, there has been an increase in production capacity of over 500,000 tons during 1955. Already announced for completion during 1956 is additional capacity in excess of 1000 tons per day. Almost weekly a new plant is announced. The 1955 production capacity was more than 4 million tons per day and was distributed evenly throughout the year. Since synthetic ammonia (about 85 percent of all ammonia produced is synthetic) is still of prime interest we have shown three different processes in the Handbook.

CARBON BLACK: With the sale of the synthetic rubber plants and the butadiene plants by the government to private industry there is a sudden boom in the rubber business. The increase of rubber formulating and the consumption of carbon black are tied closely together. The actual breakdown shows that the rubber industry used 93 percent of the carbon black produced; paints have dropped to third (displaced by inks which consume 3 to 5 percent). Channel or gas blacks are still getting their share of this business but with the advent of the practical processes for production of furnace blacks of the high reinforcing type, furnace blacks and oil blacks are gradually taking over a larger and larger share of this market. It is estimated that by 1975 oil blacks will have captured all but 15 percent of the market. Two outstanding processes for the production of these furnace blacks are shown on Pages 137 and 138.

ETHANOLAMINES: We have shown the process for the manufacture of ethanolamines for the first time in this issue (Page 144). These important petrochemicals are scheduled to break into the 100 million pound per year class in 1956. The ethanolamines have had their ups and downs in the past but seem to be lined out now for some steady moderate expansion. The original commercially produced amine was the tri-ethanolamine but it has slipped from the top position and has been replaced by the mono- and di-ethanolamines. The estimated production capacity by 1958 is 125 million pounds per year. The increased consumption of these ethanolamines is caused by increased detergent requirements as well as the increased consumption for carbon dioxide removal from ammonia synthesis gas streams (approximately 10 percent of the current production of ethanolamines is used in this service) along with the continued treatment of natural gas and refinery off-gas scrubbing. See Page 144 for the process which is versatile enough to make these three amines in any desired proportion.

GLYCEROL: Glycerine consumption in the U. S. is about 275 million pounds per year at the present time. The consumption of glycerine has been increasing at a moderate rate for quite some time while the production of natural glycerine has declined due to the advent of the synthetic detergents. Of the total consumption of glycerine in the U. S. about 50 percent or 125 million pounds is produced synthetically. The remainder of the consumption is about equally split between naturally produced glycerine and imported crude and finished glycerine. The first commercially produced synthetic glycerine was made via the epichlorohydrin route (see Page 158). This year Dow Chemical Company came into the field using this process. The newest type of process uses hydrogen peroxide and acrolein (Page 160).

HYDROCARBON POLYMERS: Polyethylene is the most talked about of all the hydrocarbon polymers. For the first time the reader can compare the three processes by turning to Page 179. While polyethylene monopolizes conversation, the major production of polymers is in the vinyls, phenolics and styrene. In 1955 the production of these plastics was in the following order: Vinyls—1250 million pounds; Styrenes—750 million pounds; Alkyd resins—660 million pounds; Phenolics—500 million pounds; Polyester resins—60 million pounds. Polyethylene production for 1955 will probably make a new high of about 382 million pounds. The acrylics, epoxies, and nylons will amount to about 100 million pounds in 1955. This will make the total fields (petrochemical—derived plastics and polymers) exceed 3 billion pounds.

SEPARATION PROCESSES: One of the major processing problems facing the petrochemical industry is the separation of products. In this Handbook you will find eleven different methods most commonly used for separation of various reaction products. The separation processes are grouped together at the end of the process section.

Another feature that the reader will appreciate about this handbook is the simplification of the indexes. We have listed all petrochemicals alphabetically. In addition all of the important intermediates have been listed in the index. This will enable the reader to use the handbook for a ready reference for most widely known petrochemicals and intermediates.

Thomas L. Ponder

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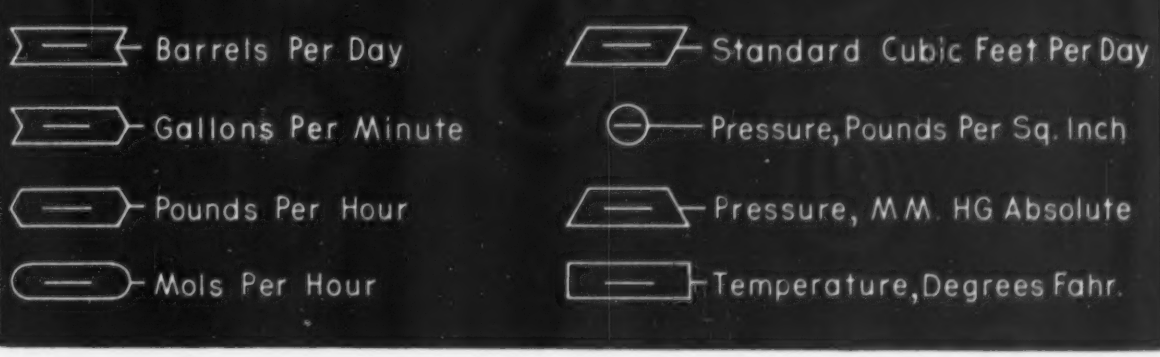


PETROCHEMICALS

Production Tomorrow

The rise to continue at a moderate pace in '56 . . . . .

Raphael Katzen
Consultant

Meet the Author

RAPHAEL KATZEN operates his own consulting service in Cincinnati, specializing in process-engineering analyses, economic evaluations, process improvements and management assistance in the petrochemical and organic industries. A graduate of Polytechnic Institute of Brooklyn, he took his master's degree there in 1938, and four years later was awarded a D. Ch. E. degree. Before starting his own business, Dr. Katzen served Cellutate, Inc., as a chemical engineer; Northwood Chemical Company as chemical supervisor; Brooklyn Polytech, research fellow; Diamond Alkali Company, technical supervisor, and Vulcan Engineering division of Vulcan Copper & Supply Company as chemical engineer, project manager and division manager.

RETURNS ARE in for '54—and reasonable estimates can be made for '55. The conclusion—petrochemical growth has continued at a good pace, and should continue on the same healthy trend.

During 1954, when total synthetic organic chemical production barely managed to advance over the levels achieved in 1953 (61,507 vs. 60,759 million pounds), petrochemical hydrocarbon intermediates production increased by 20 percent—from 11,147 to 13,446 million pounds.[2] This comparison keynotes the continuing advance of petrochemical sources of chemicals, which are accounting for a greater proportion of end-products each year.

The advance is not universal, however, and a few temporary setbacks have been noted in the past year. Acrylonitrile consumption, for example, fell far short of earlier estimates as troubles were encountered in starting up new

TABLE 1
Price Trends of Major Petrochemicals (1)
(c/#, except where noted)

	3rd Quarter, 1954	3rd Quarter, 1955
STABLE		
Acetaldehyde	10	10
Ammonia	4¼	4¼
Butanol	11	11
Ethanol (per gallon)	40	40
Isopropanol (per gallon)	39	39
Toluene (per gallon)	34	34
Vinyl Acetate	16½	16½
Xylene (per gallon)	34	34
INCREASES		
Butadiene	12½	15
Carbon Tetrachloride	8½	9
Ethylene Oxide	15	15½
Ethylene Glycol	13	13½
Methanol (per gallon)	27	30
Phenol	16	17
DECREASES		
Acetic Acid	10	9
Acetic Anhydride	14½	14
Acetone	8	7
Acrylonitrile	31	27
Benzene (per gallon)	42	36
Styrene	21	18
Vinyl Chloride	13¼	10½

facilities, and markets failed to expand rapidly—probably due in part to uncertainties of supply. These setbacks were being overcome in the latter half of 1955. Anticipated over-production of some items such as ammonia and polyethylene has not been serious because of the continued growth of markets and some delays in startup and attainment of rated production in new facilities.

A satisfactory indication of the generally parallel growth of production and markets is the stability of prices for most petrochemical items (Table 1). In a few instances, however, such as acrylonitrile, benzene and vinyl chloride, major price reductions occurred when large production facilities came on-stream or reached full capacity in 1955. Such adjustments are only natural, and are to be anticipated as a means of creating enlarged or new demands for lower cost products.

Some price increases have been noted, a few of which were readjustments from abnormally low levels (methanol, ethylene oxide, ethylene glycol), while others were probably due to temporary short supplies (butadiene, carbon tetrachloride).

In addition to the fact that surplus petrochemical production capacity has been installed and put into operation in 1955, competitive sources of production have also been expanded. For instance, although new facilities of American Cyanamid and Monsanto for petrochemical production of acetylene increased their output in 1955, major expansion was announced by Air Reduction and Linde for production of acetylene from calcium carbide. Practically all recently announced installations for acetylene derivatives will be based on pipe line acetylene supplied by these carbide producers. This is an example pointing up the warning that we must not lose sight of competitive sources because of the glamour of "petrochemicals."

With data now in hand for the year 1954, and the current year far enough along so that we can make reasonable estimates of production, an assessment can be made of the balance between supply and demand for petrochemicals in the near future. Reported and estimated figures are given in Table 2 for major petrochemicals. This table includes all production from non-petrochemical sources as well, and indicates, where data is available, the per-

TABLE 2

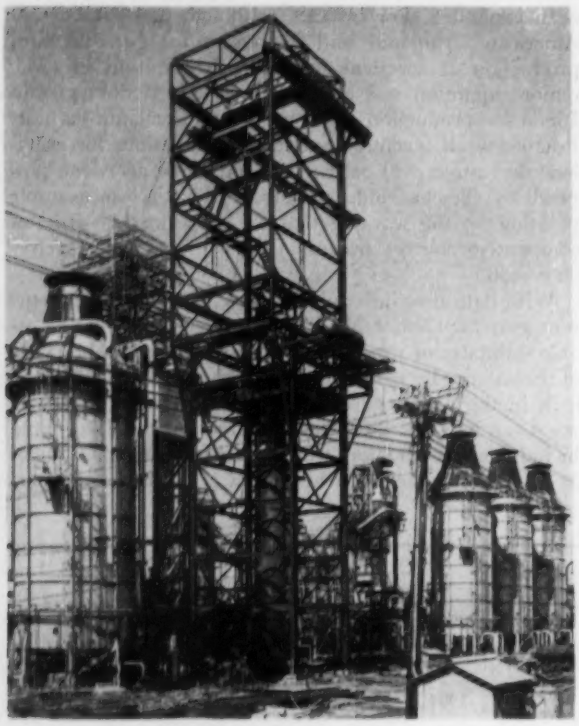
Total Production for Major Chemicals Obtained from Petrochemical and Non-Petrochemical Sources

(Millions of Pounds)

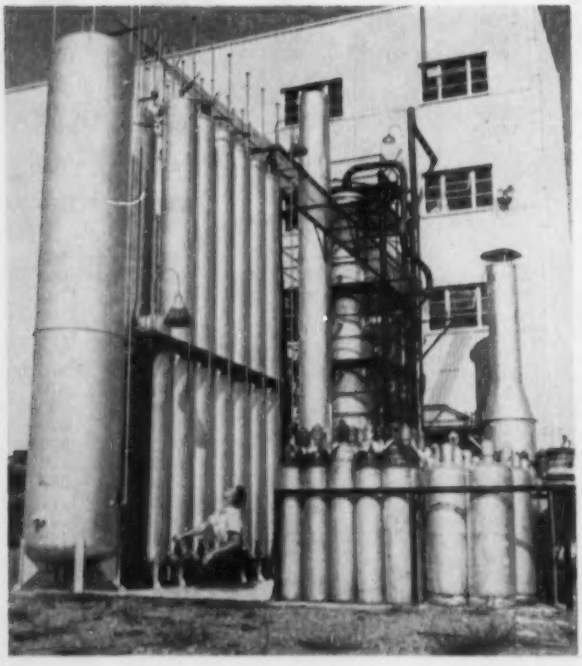
	PRODUCTION				CURRENT ESTIMATES		
	1953		1954		1955	1956	1956
	Total Amount	* Percent	Total Amount	* Percent	Production	Production	Capacity
HYDROCARBON INTERMEDIATES							
Aliphatic							
Ethylene	2136	99+	2345[2]	99+	2600	2800	3200
Propylene and Mixtures	1223	100	1204[2]	100	1300	1450	1600
Butylenes and Mixtures	1441	....	2066[2]	....	2200	2400	2400
Butadiene	1152	....	809[2]	....	1200	1400	1400
Acetylene	480	....	424[4]	....	500	650	900
Aromatic							
Benzene	1900	24	1880[2]	36	2100	2200	2600
Toluenes	1100	75	1160[2]	78	1200	1200	1500
Xylenes	900	83	800[2]	90	1000	1100	1200
Styrene	798	50	703[2]	50	800	900	1050
HYDROCARBON POLYMERS							
Polyethylene	135	100	210[5]	100	320	450	600
Synthetic Rubber	1958	....	1435[2]	....	1600	1800	2100
PHENOL	382	....	418[2]	50	460	480	600
AMMONIA	4800	75	5440[4]	85	6100	6500	7600
ALIPHATIC CHEMICALS							
Formaldehyde (100%)	439	....	380[2]	....	500	550	650
Acetaldehyde	800	....	700	....	750	800	900
Methanol	1118	80	1132[2]	80	1300	1400	1700
Ethanol	1475	72	1430[2,3]	80	1600	1700	3100
Iso-propanol	901	100	859[2]	100	900	1000	1200
Butanols	392	....	408[2]	52	450	450	450
Ethylene Oxide	490	....	580[2,3]	....	750	800	970
Ethylene Glycol	624	....	638	....	700	700	970
Acrylonitrile	57	....	63[2]	100	100	140	200
Acetic Acid	478	....	461[2]	96	500	500	670
Acetic Anhydride	804	....	691[2]	....	750	750	900
Acetone	519	....	478[2]	84	550	550	710
Carbon Tetrachloride	260	....	235[2]	....	270	280	300
Ethyl Chloride	520	....	547[2]	....	600	650	....
Ethylene Dichloride	529	....	452[2]	....	500	500	....
Trichloroethylene	323	....	297[2]	....	320	340	....
Perchloroethylene	153	....	158[2]	....	170	180	....
Vinyl Chloride	402	....	393[2]	80	450	500	650
Vinyl Acetate	....	....	106[2]	80	120	140	....

* Percent Petrochemical Production.

Production Tomorrow . . .



Oxygenated hydrocarbons tomorrow: Extensive pilot plant work was done before Stanolind reconstructed this Brownsville, Texas petrochemical plant.



cent of production from petrochemical sources.

HYDROCARBON INTERMEDIATES

Ethylene—This basic intermediate has retained its lead as the major raw material for organic chemical production. The increase in production reported for 1954 over 1953 has been followed by a further estimated rise in 1955. This growth is expected to continue at a more moderate pace through 1956, when an output of 2800 million pounds will be required from facilities having an estimated capacity of 3200 million pounds. This leaves a reasonable margin of capacity over demand in the immediate future.

For the long run, however, continued increase in ethylene requirements is anticipated. It has been reported that Gulf is considering a second expansion of their pipe line ethylene system in Texas, and that refineries in the New Jersey area are seriously planning for ethylene production in this highly-concentrated market area. Phillips will be installing ethylene facilities in connection with projected polyethylene production. These programs will not affect supply or demand in 1956, but promise further growth in '57.

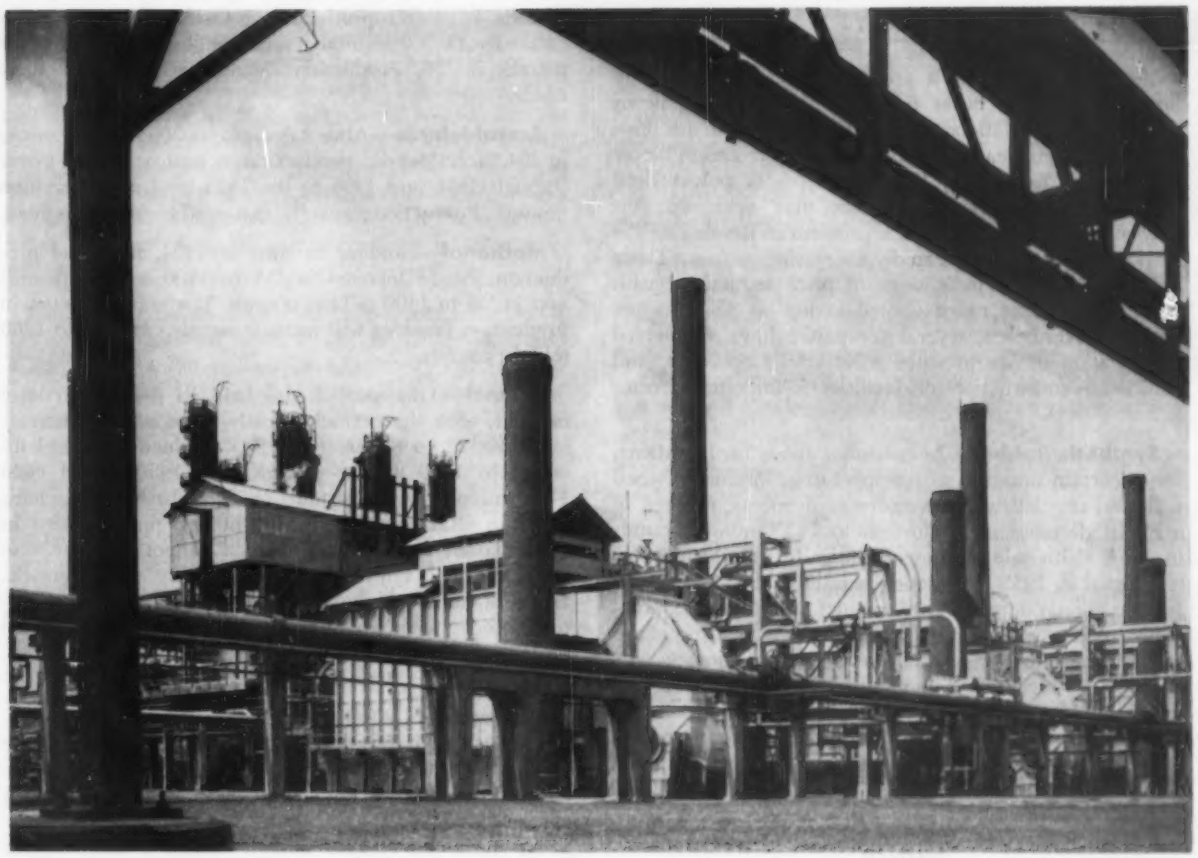
Propylene—Despite a decrease in production in 1954, major growth is estimated for '55 and '56. A comfortable but not excessive margin of production capacity will still exist in 1956. No major plans have been announced for expansion of propylene production facilities.

Butylenes—A large jump in production occurred in '54, and requirements are estimated to have increased at a more moderate pace in '55 and should do the same in '56. But—the statistics should be approached with caution, as the Tariff Commission data included mixtures of butylenes and saturated hydrocarbons—which mixtures may vary from year to year. Nevertheless, it is anticipated that production facilities will be strained in 1956, and several expansion programs have been reported. These will not affect the situation in '56, however, and a temporary tight supply situation may develop.

Butadiene—A sudden drop in production during 1954 may be attributed primarily to inventory adjustments and limited production in government-owned facilities. With sale of these facilities to private industry completed in 1955, production has proceeded at a more steady pace, and production should regain the levels reached in '53. Further growth estimated for 1956 to 1400 million pounds per year will strain existing facilities. Here again, expansion plans have been indicated, notably by Copolymer Corporation, Petroleum Chemicals, Phillips and Goodrich-Gulf. This new capacity will come on stream late in '56 or early in '57, and so cannot be calculated as available supply for 1956.

Acetylene—Here is a dark spot in an otherwise bright area of growth. In view of the optimistic predictions of rapid growth of low-cost petrochemical acetylene made about three years ago, progress has been disappointing. Operation of the two new facilities of Monsanto and American Cyanamid were delayed, and capacity production has been limited by a slow rate of development of the end products, such as acrylonitrile.

An actual decrease in acetylene production has been reported for 1954 as compared with 1953. This lost



Butadiene tomorrow: Petro-Tex Chemical Corporation's 90,000-ton per year plant will be expanded 50 percent by addition of 45,000 tons per year of butadiene from butane.

ground should be made up in 1955, with further growth at a moderate pace estimated for 1956 to a level of 650 million pounds per year. Available capacity of 900 million pounds per year, which includes new, efficient acetylene-from-carbide plants will far exceed demand. Acetylene prices will probably come down a little to encourage consumer plants to tie on to pipe-line facilities.

Benzene—Production in 1954 held close to the level achieved in 1953 of 1900 million pounds. This is estimated to increase to 2100 million pounds in '55 and then to 2200 million pounds in '56. Production capacity of 2600 million pounds is ample to take care of these requirements. It is notable that the petrochemical share of benzene production increased from 24 to 36 percent in 1954, and this proportion should increase again in '55 when new petrochemical facilities reach full production.

Toluene—Toluene production increased slightly in 1954, another moderate rise is estimated for 1955. This level of 1200 million pounds should hold through 1956. Estimated plant capacity of 1500 million pounds, most of which is petrochemical, leaves a fair margin over requirements.

Xylenes—After an appreciable drop in production in 1954, to 800 million pounds, 90 percent of which was petrochemical, 1955 production is estimated to jump to 1000 million pounds, with further increase in 1956 to an estimated 1200 million pounds. Anticipated growth of this important intermediate should require expansion of facilities in 1956 or 1957.

Styrene—This material also was reduced in output in 1954 to 703 million pounds. 1955 requirements should increase production to 800 million pounds, recovering lost ground. Further increase is anticipated for '56 to 900 million pounds. This still leaves an appreciable surplus margin of production capacity estimated at 1050 million pounds.

HYDROCARBON POLYMERS

Polyethylene—This prodigy of the petrochemical industry has kept up with estimated predictions, production having increased more than 50 percent in 1954 to a level of 210 million pounds. With new producers coming onstream in '55, and pushing market development, estimated production should rise about 50 percent again, to a level of 320 million pounds. This rate of growth may decrease slightly in 1956 to yield a production of 450

million pounds, against a projected capacity of 600 million pounds. This latter figure does not include newly announced installations by Phillips and Grace for low-pressure polyethylene, which cannot come onstream before the end of '56 or early '57. New types of polyethylene yielded by low-pressure processes may open up new markets, but producers have a problem in developing the markets to absorb the rapidly increasing output. There have already been indications of price reductions, with some polyethylene resins quoted as low as 35 cents per pound. Nevertheless, several companies have announced investigation of low-pressure polyethylene processes, and additional construction of facilities is anticipated after 1956.[6]

Synthetic Rubber—As indicated above for butadiene, the uncertain situation with respect to government-owned facilities, coupled with inventory adjustments, resulted in a major decrease in production to 1435 million pounds in 1954. With sale of these facilities to private industry completed in 1955, production is estimated to increase to 1600 million pounds. With product improvements, synthetic rubber will continue to take an increasing share of the rubber market. An output of 1800 million pounds is estimated for 1956. Although production facilities will still provide some surplus capacity at the end of '56, further growth is foreseen, and plans have been announced by Firestone, Goodyear, and other purchasers of government plants to expand these facilities in 1956 and 1957.[7]

PHENOL

Output of phenol increased to 418 million pounds in 1954, of which approximately 50 percent was of petrochemical origin. Growth of plastics production in 1955, the major consumer of phenol, should require an increase in production to 460 million pounds. A further moderate increase to 480 million pounds is estimated for 1956, against a capacity of 600 million pounds.

AMMONIA

Despite many pessimistic predictions that markets could not keep up with rapidly expanding capacity, ammonia has continued as the largest volume growth petrochemical. An increase of about 13 percent resulted in 1954 production of 5440 million pounds. With new distribution and storage facilities in operation, 1955 production is estimated at 6100 million pounds, and should reach 6500 million pounds in '56. Petrochemical sources already account for 85 percent of ammonia production, and this ratio should hold for the immediate future.

With the large number of announced plans, but uncertainty of financing of new ammonia plants, it is difficult to predict projected production capacity. A reasonable estimate, however, is that 1956 year-end capacity should be 7600 million pounds. This surplus will not be as great as first appears, as several facilities will come into production late in the year. The agricultural fertilizer market will continue to expand, particularly as new plants located centrally in agricultural areas bring down the delivered price of amonnia.

ALIPHATIC CHEMICALS

Formaldehyde—Having decreased to 380 million pounds in 1954, production is estimated to increase markedly to 500 million pounds in '55 and 550 million pounds in '56. Production capacity is ample for these needs.

Acetaldehyde—After a decrease to 700 million pounds in '54, acetaldehyde production is estimated to recover through 1955 and 1956 to the 1953 level of 800 million pounds. Production capacity can readily meet this load.

Methanol—Holding its own in 1954, methanol production should increase in '55 to 1300 million pounds and in '56 to 1400 million pounds. Moderate increases in production facilities will increase supply capacity to 1700 million pounds.

Ethanol—This alcohol also held its production level in 1954, with the petrochemically based portion increasing from 72 to 80 percent. 1955 production should increase to 1600 million pounds, and 1956 should yield 1700 million pounds production. The large surplus indicated in total capacity of 3100 million pounds exists in fermentation alcohol plants which cannot compete economically with synthesis processes. Many of the fermentation plants are being scrapped, and this statistical surplus should decrease. On the other hand, additional synthetic capacity should be on stream in 1956 at Standard of Indiana's synthetic fuel plant in Texas.

Isopropanol—After a moderate decrease in production for 1954, isopropanol production is estimated to be 900 million pounds in '55 and 1000 million pounds in '56. These increases are anticipated as a result of growing use of isopropanol as a gasoline additive. Production capacity estimated at 1200 million pounds is sufficient for needs in the immediate future.

Butanols—Only moderate growth is estimated, to 450 million pounds in '55 and '56. This should be in balance with supply, and more capacity may be required.

Ethylene Oxide:—Some recovery was noted in 1954 from the depressed production levels of 1953. Major increases in consumption during 1955 attributable to detergent, plastic and syntheic fiber end-uses should yield a production of 750 million pounds. Further increase to 800 million pounds is estimated for 1956. With new plant capacity in production in 1955, total supply potential of 970 million pounds can meet these needs comfortably.

Ethylene Glycol—This product also recovered in 1954 from a depressed production level in 1953. An increase to 700 million pounds is estimated for '55, with no appreciable growth in '56. Decreasing anti-freeze use should just about be balanced by increase in synthetic fiber and plastic use. Production capacity of 970 million pounds exceeds projected demands very appreciably.

Acrylonitrile—For reasons noted earlier in this article, the growth in acrylonitrile production in 1954 was disappointing, reaching a level of only 63 million pounds. During 1955, however, progress was made in overcoming startup and end-product difficulties. Production for this year should reach 100 million pounds, and in '56 is estimated as 140 million pounds. This is still far below the production capacity of 200 million pounds. Price drops have already been recorded as an encouragement to increase consumption. Acceptance of acrylic fibers as wool

substitutes is the major factor which is counted upon to increase acrylonitrile demands.

Acetic Acid—Production decreased slightly in 1954, and should increase in '55 to 500 million pounds, holding this level in '56. Although an excess of capacity already exists, additional production should become available in '56 as a by-product of Standard of Indiana's synthetic fuel plant. A total capacity of about 670 million pounds is far in excess of demand, and may result in some price reductions.

Acetic Ayhydride—After an appreciable reduction to 691 million pounds in 1954, acetic anhydride production is estimated at 750 million pounds for 1955 and 1956. Recovery to the 1953 level of 804 million pounds is not anticipated because of the competition of new synthetic fibers displacing some cellulose acetate production—a major user of the anhydride. Here again, existing capacity is more than ample for needs.

Acetone—A considerable excess of plant capacity over market requirements will exist, mainly because of new production of acetone as a by-product of phenol synthesis. A production increase estimated for 1955 and '56 to 550 million pounds is considerably less than existing capacity of 710 million pounds. Here too, further price adjustments may be encountered.

Chlorinated Aliphatic Chemicals—This group is listed in detail in Table 2, for all items exceeding 100 million pounds per year production. Capacity data is not readily available, as some are by-products, and many are produced in a large number of small installations. Although raw materials may be petrochemical or coal in origin, the petrochemical portion is generally increasing. Greatest growth is estimated for ethyl chloride and for vinyl chloride.

Vinyl Acetate—Just entering the 100 million pound per year class, vinyl acetate is estimated to show continued growth, to 120 million pounds in '55, and 140 million pounds in '56. Plastics use accounts for the major consumption.

WHAT'S AHEAD?

With major expansion achieved in the past few years, the petrochemical industry now heads into a period of moderate growth and stabilization coupled with a more competitive market situation. In most categories covered in this report, production capacity exceeds market requirements. This is a healthy and normal economic situation—as long as production is at a level of at least 80-85 percent of capacity. In very few cases can break-even points be maintained with output below this percentage of plant potential.

In only a few items are market demands straining production capacity. In these cases, we find that the industry is on its toes, and expansion plans have been announced, or are being formulated. Butylenes, butadiene and synthetic rubber are in this category.

On the other hand, we have encountered during the past year the difficult growth situation which often occurs when production facilities are installed at a rapid rate, and market developments fail to keep pace. Acrylonitrile and polyethylene are going through these growing pains. There is little question, however, that the long range projection for these products is promising. The existing efficient production facilities permit price reductions which will foster the growth of markets. This type of development requires large-scale investment by companies which can afford to wait for reasonable returns.

In planning for the future, the petrochemical producer can look toward the following potential growth areas:

- **Hydrocarbons**—Ethylene, butylenes, and butadiene will require expansion at a steady rate. Acetylene will develop more slowly than previously estimated.
- **Aromatics**—Benzene, toluene and xylene will require further expansion in two or three years. Their derivatives will also become of interest to the petrochemical producer.
- **Hydrocarbon Polymers**—Synthetic rubber will take a growing percentage of a steadily increasing market. Expansion will be required steadily over the next decade.
- **Ammonia**—Saturation is not yet reached—capacity is needed in areas suffering from high transportation costs. These localized agricultural markets can absorb output of new plants at an increasing rate.
- **Aliphatic Chemicals**—Many of these are leveling off, but some such as ethylene oxide, ethylene glycol, vinyl chloride and carbon tetrachloride will require expansion in the next two or three years as new markets develop.

Competing raw materials, such as coal, coke, wood, sugar, etc. can never be overlooked. Improved furnaces for production of calcium carbide from coke have permitted expansion of acetylene facilities at low-cost power locations, notably Calvert City, Ky.; Portland, Ore.; and Niagara Falls, N. Y. This acetylene is directly competitive with petrochemical acetylene.

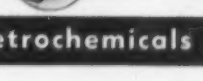
A new process has recently been announced for production of detergents from sugar—a high-purity, low-priced tonnage material. This could displace some petrochemically derived detergents.

Low-pressure hydrogenation of coal is now being pilot-planted, and can yield a wide variety of aromatic chemicals in large tonnage. Synthesis gas processes have been improved recently by duPont and Texaco so that synthesis gas for ammonia or synthetic fuels can be produced from coal or coke as readily and economically as from petroleum or natural gas sources.

Any company investigating petrochemical processes must therefore check not only alternate processes, but competing raw materials and competing end-products as well.

LITERATURE CITED

[1] *Chemical and Engineering News*—Quarterly Reports on Prices.
[2] U. S. Tariff Commission Report No. 196, Second Series Synthetic Organic Chemicals—U. S. Production and Sales, 1954.
[3] Matthew, C. J., Messing, R. F., and James, R. L.—*Chemical Engineering*, Sept. (266), Oct. (280), 1955.
[4] U. S. Bureau of Census Data—Private communication.
[5] Guthrie, V. B.—*Petroleum Processing*, Sept. (1387), 1955.
[6] Gordon, J. PETROLEUM REFINER—Feb. (107), March (187), 1955.
[7] *Chemical and Engineering News*, Sept. 19 (3972), 1955.



Petrochemicals

PETROCHEMICALS

Raw Materials Today

What will you be using for starting material—

- Natural Gas
- LPG
- Refinery Off-Gas
- Residual Fuel Oils

J. J. McKetta and Thomas C. Ponder
Petroleum Refiner Staff

THE GROWTH OF the petrochemical industry during the past 15 years has been phenomenal . . . from 4 billion pounds in 1940 to almost 25 billion pounds in 1954 having a value in excess of $3 billion. The present raw materials being used by the petrochemical industry are natural gas, LPG, refinery off-gases, and residual fuel oils. Of these materials natural gas and LPG are the most widely used at the present time. Refinery off-gases are increasing in use as raw materials and the heavy residual fuel oils are beginning to be recognized as a good source for petrochemical manufacture.

Questions uppermost in the minds of manufacturers and the raw material suppliers include:

- **Natural Gas**—How will price increases affect its use as a raw material? When does the cost of natural gas force the manufacturer to use some other raw material?
- **LPG**—Will the large supply of liquid petroleum gases be utilized to stabilize raw material supply or will they become the prime raw material?
- **Refinery Off-Gases**—Are these gases being used to their maximum economic advantage?
- **Fuel Oil**—Where can heavy fuel oils compete as raw materials?

The answer to these questions would solve most of the supply problems. Industry can look at the future with the background of the immediate past as a good guide. Raw materials used in the manufacture of petrochemicals always will be selected on the basis of price, supply, and dependability of supply. The slight connection between oil refineries and petrochemical plants will not influence the choice of raw materials. Chemicals still only account for about 6 percent of the total crude oil produced. Less than 1 percent of all crude actually finds its way into chemical end products.

It is this small percentage of the refining industry, which will amount to $5.2 billion annual business in the next decade, which is of vital concern today.

NATURAL GAS—The first raw material to be considered is natural gas. Figure 1 shows the natural gas production (gross) in millions of cubic feet each year since 1936 as well as various consumption figures for residential, commercial, and industrial along with values at points of consumption. It will be noted that the wellhead price has increased 182 percent up to 1954 with total production increasing 416 percent. Residential consumption has increased 560 percent with an 121 percent increase in value. Commercial consumption has increased 540 percent with 132 percent increase in value. Industrial consumption has increased 339 percent while increasing 193 percent in value. If the curves in Figure 1 are extrapolated until 1960 we find consumption quantities and values as follows:

	Residential		Commercial		Industrial	
Year	Consum[1]	Value[2]	Consum[1]	Value[2]	Consum[1]	Value[2]
1954	1,920,000	88.5	600,000	63.7	5,780,000	19.3
1960	3,410,000	1.00	920,000	80.0	7,850,000	25.0
% Increase	177	113	153	125	136	129

[1] Millions of Cubic Feet. [2] Cents per M Cu. Ft.

With reserves at 221.5 trillion cubic feet at the end of 1954 and production at 9.4 trillion cubic feet this gives us a ratio of reserves to production of 23.5. While produc-

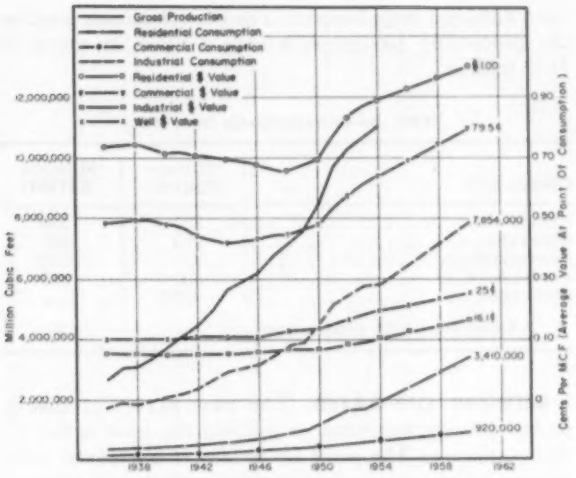


FIGURE 1—Natural Gas—Production, consumption, and value.

tion has been increasing steadily reserves have also increased at a faster rate and it is logical to assume that natural gas will be available for all uses for some time to come. The amount available and the cost will be determined by many variables not the least of which is national and state legislation. From the extrapolation of Figure 1, it can be seen that the expected increase in consumption by industrial users and the expected increase in value will increase by about the same percentage. Residential and commercial consumption is expected to increase by a larger percentage and this is indicative of the trend for natural gas to be used as fuel rather than raw materials for petrochemical manufacture.

Approximately 25 percent of all chemicals produced start with natural gas. At the present time, only about 5 percent of the natural gas produced finds its way into petroleum refining and petrochemicals. If the data of Figure 2 are extrapolated to 1960 it can be seen that the total production of petrochemicals will approach 39.5 billion pounds annually with inorganic chemicals making up 17.5 billion, aromatic making up 6 billion, and aliphatics making up 16 billion pounds.

Of the major petrochemicals having natural gas as their starting material the production is distributed as follows:

ETHYLENE—Approximately 2.0 billion pounds were produced in 1954 and it is estimated that the 1962 production will be in excess of 4.0 billion pounds. Seventy percent of the ethylene was produced from natural gas.

AMMONIA—The 1954 production of ammonia from natural gas was in excess of 1100 tons per day.

METHANOL—Approximately 226 million gallons will be produced in the U. S. in 1955, with 64 percent from natural gas.

ACETYLENE—Approximately 100,000 tons were produced from natural gas in 1954.

CHLORINATED METHANES—In 1954, the production of chlorinated methanes were as follows: methyl chloride, 65 million pounds; methylene chloride, 60 million pounds; and carbon tetrachloride, 300 million pounds. These petrochemicals were all produced from natural gas.

The most important natural gas derived petrochemicals (Ethylene and acetylene) are really intermediates used in the production of a large number of end use petrochemicals.

Ethylene is the most widely used compound for making end use petrochemicals. As stated eariler ethylene production was 2.0 billion pounds in 1954 and was consumed as follows:

Ethanol	30%	Styrene	11%
Ethylene Oxide	25%	Ethylene dichloride	7%
Ethylene dibromide	2%	Ethyl Chloride	10%
Polyethylene	10%	Miscl.	5%

Ethanol production in 1954 was in excess of 214 million gallons, of which 68 percent was from ethylene. Forty-six percent of the ethanol was used for aldehyde manufacture, 27 percent for solvents, 20 percent for other chemical uses, and 7 percent miscellaneous.

Ethylene oxide production for 1954 was in excess of 580 million pounds and was consumed as follows: Ethylene glycol, 64 percent; glycol ethers and polyglycols, 11 percent; ethanolamine, 8 percent; acrylonitrile, 5 percent; detergents, 10 percent; and 2 percent miscellaneous.

The ethylene glycol production for 1954 was about 600 million pounds, 83 percent being produced from ethylene oxide and 17 percent from formaldehyde and carbon monoxide. Ethylene glycol is consumed as follows: antifreeze, 80 percent; Dacron and Mylar, 4 percent; cellophane, 6 percent; dynamite, 5 percent; and 5 percent miscellaneous.

Approximately 70 million pounds of Acrylonitrile was produced in 1954 with 54 percent made from hydrogen cyanide and ethylene oxide and 46 percent from hydrogen cyanide and acetylene. Hydrogen cyanide and ethylene oxide are produced from natural gas and about 10 percent of the total acetylene production is from natural gas. The end uses of acrylonitrile are: synthetic fibers, 53 percent; synthetic rubber, 19 percent; plastics, 19 percent; and 9 percent miscellaneous.

Methanol production in 1955 will exceed 226 million pounds and will be used as follows: formaldehyde manufacture, 49 percent; antifreeze, 27 percent; chemical synthesis, 8 percent; solvents, aviation and denautrants, 8 percent; and 8 percent miscellaneous.

The value of these petrochemicals produced from natural gas is enormous. A few are shown in Table 1 and amount to $523 million. Ethylene is estimated to cost 3 to 6.5 cents per pound and with 2.0 billion pounds being produced annually this amounts to $60 million to $130 million per year. Acetylene from natural gas costs about 6 cents per pound and with approximately 200,000,000 pounds being produced amounts to $12 million business annually.

TABLE 1—Petrochemicals From Natural Gas

Compound	Million $ Value	Compound	Million $ Value
Ethylene Oxide....	$ 52.5	Polyethylene.....	$ 42
Ammonia*.....	$ 35.3	Styrene monomer..	$ 27
Methanol.....	$ 51	Ethylene dichloride	$ 11
Methyl chloride, methylene chloride, and carbon tetrachloride.....	$ 47.5	Ethyl Chloride.....	$ 14
		Acetaldehyde.....	$ 9.8
		Ethylene Glycol....	$ 78
		Acrylonitrile.....	$ 24
Ethylene Bromide..	$ 0.84	Formaldehyde.....	$ 110
Ethyl Alcohol.....	$ 21		

* Estimated 1955 production.

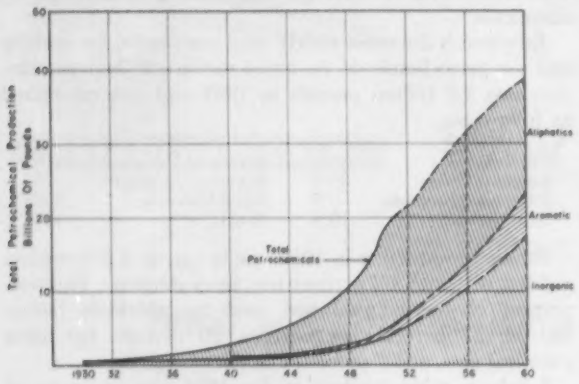


FIGURE 2—Total petrochemical production.

LIQUEFIED PETROLEUM GASES—The next raw material to be considered is LPG. Figure 3 indicates the total amount of LPG marketed from 1936 through 1954. The curves in Figure 3 have been extrapolated to indicate the expected consumption for chemicals in 1960. It can be seen that the expected demand for LPG for petrochemicals in 1960 will be about 1,550,000,000 gallons. About 10 percent of the total LPG production goes into chemicals, including the amount of LPG that goes into synthetic rubber production (Butadiene). Chemical manufacture from LPG has grown from about 414 million gallons in 1947 to approximately 977 million gallons in 1954. It is estimated that by 1960 over 20 percent of the total LPG marketed will be used as raw materials for petrochemicals.

The supply of LPG has been increasing and can be expected to increase despite any cutback of crude to stills. In 1954 there were 20 new sources for LPG completed with a total capacity of 700 million gallons. In 1955 fifteen new plants will be completed with a design capacity in excess of 200 million gallons.

LPG is currently selling in contracts in the Southwest and Gulf Coast for an average of 3.5 cents per gallon. New York harbor prices run as high as 7.5 cents. This means that the amount of LPG used for petrochemicals in 1955 amounted to $34 million. Referring to Figure 3 again, we can see that the 1960 demand for petrochemical manufacture will amount to $54 million in LPG gas purchases. In 1955 approximately $11 million worth of LPG was used in the manufacture of synthetic rubber and it is expected that by 1960 this will have increased to $17.5 million.

LPG is the raw material for the manufacture of the following petrochemicals; Ethylene, acetaldehyde, formaldehyde, acetic acid, methanol, acetone, n-butyl alcohol, propylene glycol, n-butylenes, and many others. Production of these major petrochemicals is shown in Table 2.

The distribution and end use of these petrochemicals already has been discussed in the foregoing section on natural gas.

As stated previously the value of the LPG used in the manufacture of petrochemicals in 1955 will be about $34 million. The value of just a few of the chemicals produced from LPG is shown in Table 2.

It should be obvious that petrochemical manufacture from LPG is a large business. The petrochemicals listed in the proceeding paragraph having a value in excess of $139 million.

TABLE 2—Petrochemicals from LPG.

Compound	Million Pounds	Millions $ (1954)
Ethylene	800	$48
Acetaldehyde	210	$21
Formaldehyde	334	$20
Acetic Acid	500*	$50
Methanol	0.1	...

* Estimated 1955 production.

REFINERY OFF-GASES—The raw material that is probably being neglected or misused the most is the refinery off-gases. The gases are usually rich in many components which are ideally suited for petrochemical manufacture. These components include along with methane, hydrogen, and propane such components as propylene, n-butylene, isobutylene, heptenes, and cyclohexanes, as well as the heavier aromatics that are often carried along with the gas stream.

Petrochemical plants are making many useful chemicals from these so-called off-gases. For example, the following are made from propylene: isopropyl alcohol, acetone, and other solvents, propylene tetramer from which comes many detergents, cumene from which is made phenol and acetone, allyl chloride from which glycerine is derived.

The largest tonnage petrochemical made from this off-gas is ammonia with 1955 expected production being in excess of 815 tons per day in the U. S. This is made from the hydrogen in the off-gas which has a value of 40-50 cents per thousand cubic feet when used for ammonia manufacture rather than fuel.

About 10 percent of the total ethylene production (200 million pounds per year) is made from refinery off-gases. The cheapest ethylene made is that which comes directly from the refinery off-gas ethane.

Phenol from cumene is becoming a very important process. The total production for 1955 of phenol from cumene will be about 91 million pounds. Along with this phenol there is made also about 54 million pounds of acetone. All this phenol starts with refinery off-gas propylene.

Synthetic glycerine production is steadily climbing and will reach a total production for 1955 of about 140 million pounds. This amounts to almost half of the total U. S. consumption. Practically all of this glycerine started with propylene from refinery off-gas.

The source of most of these refinery off-gases are the cracking and reforming processes used to make motor fuel. It is estimated that by 1965, fifty percent of the gasoline demand will be produced by catalytic reforming and 37 percent by catalytic cracking. This will make a tremendous amount of refinery off-gas available for petrochemical raw material.

Figure 4 indicates the consumption trend of refinery off-gas in the manufacture of petrochemicals. It will be noticed that by 1960 refinery off-gases used in the manufacture of petrochemicals will have increased to 2700 million pounds per year.

Of the petrochemicals produced from refinery off-gas in

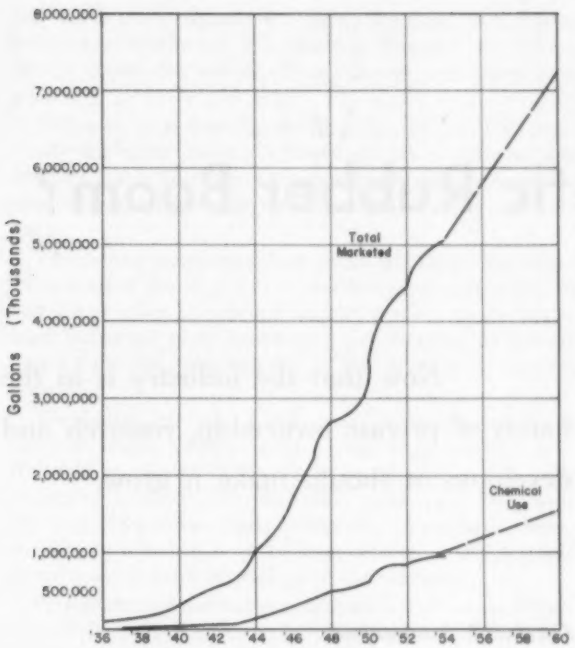


FIGURE 3—LPG—Total marketed and used in chemicals.

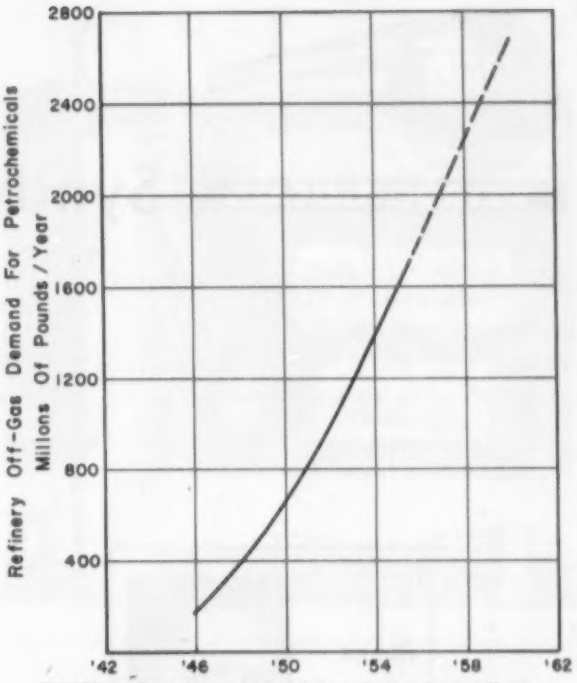


FIGURE 4—Petrochemical manufacture from refinery off-gas.

TABLE 3—Petrochemicals from Refinery Off-Gas.

Compound	Million $ (1954)
Ammonia	$25.3
Ethylene	$ 6
Phenol	$14.5
Acetone	$ 3.8
Glycerine	$40.6

1954, data is only available for a few. The values of these petrochemicals produced in 1954 are shown in Table 3.

These raw materials will be increasing in years to come and it can readily be seen the excellent source they will make for petrochemicals.

FUEL OIL—The petrochemical raw material that has been neglected the longest is now beginning to be recognized—heavy residual oil. In locations where gas or LPG are not available many petrochemicals can be manufactured from fuel oil. It is estimated that by 1965 the total refinery demands will total approximately 11 million barrels daily of which about 2 million barrels of the production will be residual fuels. These offer reliable and inexpensive sources for petrochemical raw materials.

Already some manufacturers have started using these residual fuels for petrochemical manufacture. Some 250 tons per day of ammonia production is soon to go on stream in the U. S. using fuel oil as the raw material. There is a total of 895 tons per day of ammonia production (under construction or operating) outside the U. S. using fuel oil as the raw material.

Residual fuels account for approximately 10 percent of the annual ethylene production or about 200 million pounds.

The data on petrochemicals being manufactured from fuel are very incomplete but by extending that which is available some interesting trends may be developed. The value (selling price) of fuel oil that could be used as raw materials for petrochemicals ranges from $2.50 to $1.92 per barrel. The value of the products on which data is available is as follows: Ammonia, (U. S. production), $7.75 million; Ammonia (foreign), $27.7 million; and Ethylene, $12.0 million. From this data it would seem that products values at $46.4 million are being produced from raw materials valued at $6.4 milion.

The outlook for the petrochemical industry is outstanding. It is expected that the demand for hydrocarbons by petrochemical industry will be about 140,000 barrels per day of which 70,000 barrels are aliphatic and 70,000 barrels are aromatic. While this is only about 1.3 percent of the total refinery production it amounts to about 5 percent of the volume of premium grade motor fuel production. This will mean that the refining industry will not be able to meet the petrochemical demand for aromatic raw materials and this demand will be met from other sources of raw materials, such as LPG and natural gas.

In the next 10 years the chemical and allied sales per year will be climbing to an annual sales value of $40 billion. It is expected that organic chemicals will increase at 10 percent per year and plastic production will increase 11 percent. Ammonia production is expected to double in the next ten years along with formaldehyde. Glycols will increase 50 percent and there will be 30 percent more phenol production in the next ten years.

From the expected growth rates it is obvious that raw materials will play a very important role in the petrochemical future. ##

Petrochemicals

PETROCHEMICALS

Synthetic Rubber Boom?

Now that the industry is in the hands of private ownership, research and development should make it grow.

Clayton F. Ruebensaal
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Meet the Author

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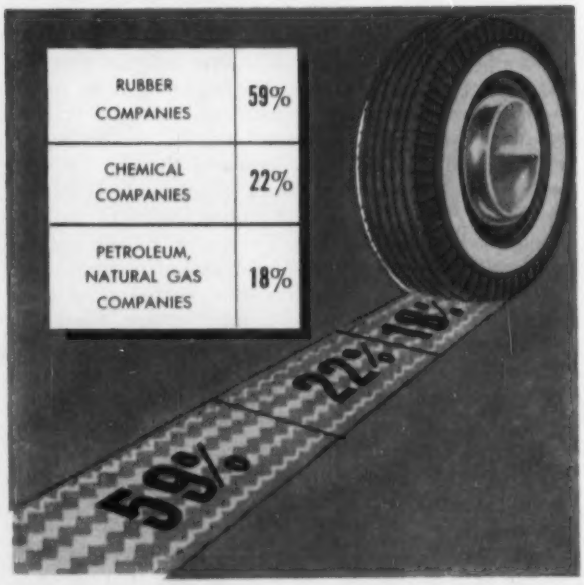
A graduate of Case Institute of Technology, he was one of the organizers of the Chemical division of Glenn L. Martin Company, and was, in large part, responsible for the initial research, development and production of Marvinol polyvinyl chloride resins. He joined Naugatuck Chemical in 1949 when the company acquired Martin's Chemical division. In 1945 and 1946 he was one of the group of technical consultants who visited Germany at the invitation of the U. S. government to study German methods of plastics production and research.

APRIL OF THIS YEAR marked the beginning of a new private industry as the government disposed of the synthetic rubber producing facilities. For approximately $300 million, a going business consisting of 13 synthetic rubber plants, 10 monomer plants and 1 miscellaneous facility became a private enterprise.

The synthetic rubber industry, although one of the largest manufacturers and users of petrochemicals, with



Rubber companies own a major share of the synthetic rubber industry.

two-thirds of its capacity located in the heart of the great petroleum Southwest, is actually a diversity of interests spread across the rubber, chemical and petroleum companies.

Although these new owners have started out with practically the same amount of information on process and product know-how, their various basic objectives would tend to point future development efforts along different lines.

The rubber companies, both small and large, purchased 64 percent of the total S-type (formerly designated GR-S) copolymer plant investment and 24 percent of the petroleum butadiene plant investment (representing 59 percent and 22 percent, respectively, of the total on a capacity basis).

The initial interests of this group of companies was in low cost, high, uniform quality raw materials with controllable properties yielding rubbers adaptable to a wide variety of products and fabrication techniques. They were also interested in the ready availability of synthetic rubber permitting inventories to be kept as low as possible and so reducing the risk of wide price fluctuations.

Petroleum and natural gas companies today own 25 percent of the total copolymer plant investment and 48 percent of the petroleum butadiene plant investment (representing 18 percent and 48 percent, respectively, of the total capacities).

Basic Raw Materials—It appears quite likely that petroleum and natural gas feed stocks will continue as the principal basic raw material sources for synthetic rubbers. As long as this remains true, this group of companies can be expected to take an ever-increasing interest in promoting new products and in end use diversification of the existing materials, particularly in the field of monomers.

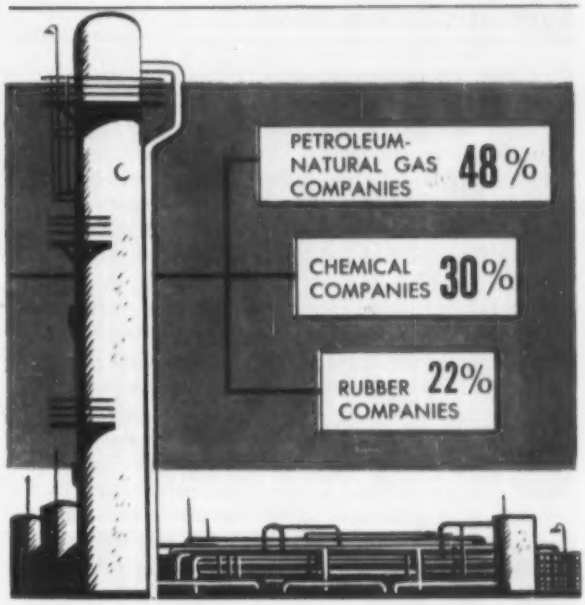
Chemical companies have invested in the former government facilities to the extent of 11 percent of the total copolymer plant investment and 28 percent in the petroleum butadiene plant investment (representing 23 percent and 30 percent of the respective totals on a capacity basis). The chemical companies who actually purchased government facilities, in addition to other chemical concerns actively engaged in the production of plastics and other types of synthetic rubbers, will be guided by their industry's pattern of continual introduction of new products. These products will result from intensive research and development activities and be supported by rapid payout times on production facilities, characterized by most developments in the chemical field.

The ultimate product of this new private industry's combined efforts to satisfy these aims should be one of rapid technological growth resulting in new and novel production methods and better products at lower cost.

This approach is sorely needed in the field of rubber, particularly with synthetic rubber if it is to hold its own against ever-increasing inroads made by other materials.

It is true that today synthetic rubber is a great development—probably ranking along with the large-scale development of atomic energy as one of the outstanding chemical engineering achievements of recent times.

However, despite the government's expenditure of $27 million on synthetic rubber research in the last five years the industry has not experienced a tremendous advance-



The beginning of the butadiene ownership—how will the pattern change?

ment in rubber types or process innovations over those adopted from private industry for the start of the program 14 years ago. Cold rubber, oil and carbon black masterbatching and some continuous polymerization methods are probably the most significant advances introduced under federal sponsorship of research.

The government's annual research budget averaged around $5 million in recent years. It might be expected that as private industry gets geared up to carry out its traditional research and development effort that two or more times this amount will be devoted by it to the development of new general purpose rubbers and methods for making them. This amount will be in addition to the vast sums already being spent to improve and introduce new special purpose types.

Federal vs. Private Spending—Despite this large expenditure of private funds, some proponents still argue for the continuance of government expenditures in the contention that the Defense Department will need specific rubber types which may provide no profit incentive to industrial research.

The decision of the federal government's future role in synthetic rubber research at the $2,200,000 Akron pilot plant and testing laboratory now lies in the hands of a 11-member commission set up by the National Science Foundation. The commission's recommendation, to be reached before the end of 1955, will be a choice between:

- Retention under government ownership and operation.
- Sale or lease to a non-profit organization which must, in turn, agree to give priority to Defense Department projects.
- Sale or lease to a private research foundation, probably industry-wide, or
- Outright sale to the highest bidder.

Regardless of the outcome of this decision, industry will

accelerate its current heavy development expenditures devoted to new and superior rubbers. This program has already introduced to the rubber market new liquid butadiene polymers; copolymers of butadiene with vinyl pyridine and acrylic acid for applications, respectively, requiring solvent resistance and high tensile strength; silicone types for severe temperature extremes, and the saturated fluorocarbon and chlorosulfonated ethylene polymers for resistance to heat and corrosive chemicals. A synthetic rubber molecule closely approximating that of tree rubber has been developed and announced as having the desirable low hysteresis characteristics of the natural polymer.

Gum and liquid polyurethan rubbers—sometimes termed "polyester" or "isocyanate" rubbers—are also winning commercial acceptance. The liquid form is the most formidable competitor, replacing small but increasing percentages of natural and S-type latices in the foam rubber industry. Although some further encroachment upon the markets of general purpose rubbers can be expected, it is anticipated that the growth of polyurethan rubbers will come about in new fields opened up by their specific characteristics. This pattern has been historically true as synthetic resins were successively introduced commercially.

The synthetic rubber industry has also stood its first "trial by competition" in the initial seven months of private operation by attaining a rate of production exceeding the highest ever attained during Government operation. This is especially significant when it is realized that this record was made with the 122,000 LT Institute plant idle.

Rubber Prices Up—Due to the unprecedented demand for rubber in 1955, the price of natural rubber increased to a high of 50 cents per pound. This peak could have been considerably higher if the outstanding production output of S-type rubber had not been achieved.

To further discharge its responsibility in operating this giant rubber producing industry, private enterprise is expending large sums of money on the expansion of these facilities. These moves, to meet future new rubber demands, will combat any further runaway pricing of natural rubber.

General purpose S-type capacity sold by the government to private industry totals 733,600 LT, with the very real possibility of the Institute plant's rated capacity of 122,000 LT being added early next year by way of its disposal and reactivation.

New capacity already added and that planned to be on stream by early 1957 is approximately an additional 250,000 LT as totaled up from a number of publicly announced and several private communications regarding expansion plans. Even with Institute's future realistic capacity pegged at somewhat below 100,000 LT (as it would be producing a diversity of types privately) it may be seen that the U. S. will have the capacity to produce—on a "net polymer"* basis—nearly 1 million long tons of general purpose rubbers by early 1957. This figure on a "net polymer" basis is stresses here as the real impact of additional oil masterbatch capacity has been given insufficient attention in arriving at the amount of general purpose synthetic rubber available to the total new rubber supply.

Both the percentage of oil masterbatch rubber used and its oil content has steadily increased in recent years. This trend may be expected to continue for some time, permitting oil masterbatch rubbers to command a larger share of the market as better oils are introduced and compounding technology continues to advance. The "net polymer" capacity of the country cited previously, could in terms of "net rubber" (i.e., including the oil content) exceed 1,150,000 LT by 1957.

Other specialty synthetic rubber capacity in the country today, including (in increasing order of their probable growth rates) butyl, nitrile, neoprene and the Thiokol types reaches close to 200,000 LT. By 1957 it is expected these special-purpose rubber facilities will be enlarged to approximate 250,000 LT, bringing the U. S. total synthetic production capacity near the 1,400,000 LT mark.

Foreign synthetic rubber plants now in operation in West Germany (Huels), coupled with new facilities planned for operation by 1957 in Italy, Germany (Bayer) and Great Britain will bring the total of these countries to about 75,000 LT. Canadian production of 125,000 LT swells the free world synthetic production total, other than U.S.A., to 200,000 LT by 1957, almost double the present rate of production. By 1960 expansions in the above listed facilities and new plants planned for Japan and India will bring the free world total to approximately 385,000 LT. It is estimated that Russia and its satellite countries including 45,000 LT in East Germany (Schkopau) constitutes an additional synthetic production capacity approximating 300,000 LT at present and reported to be expanding to 500,000 LT by 1960.

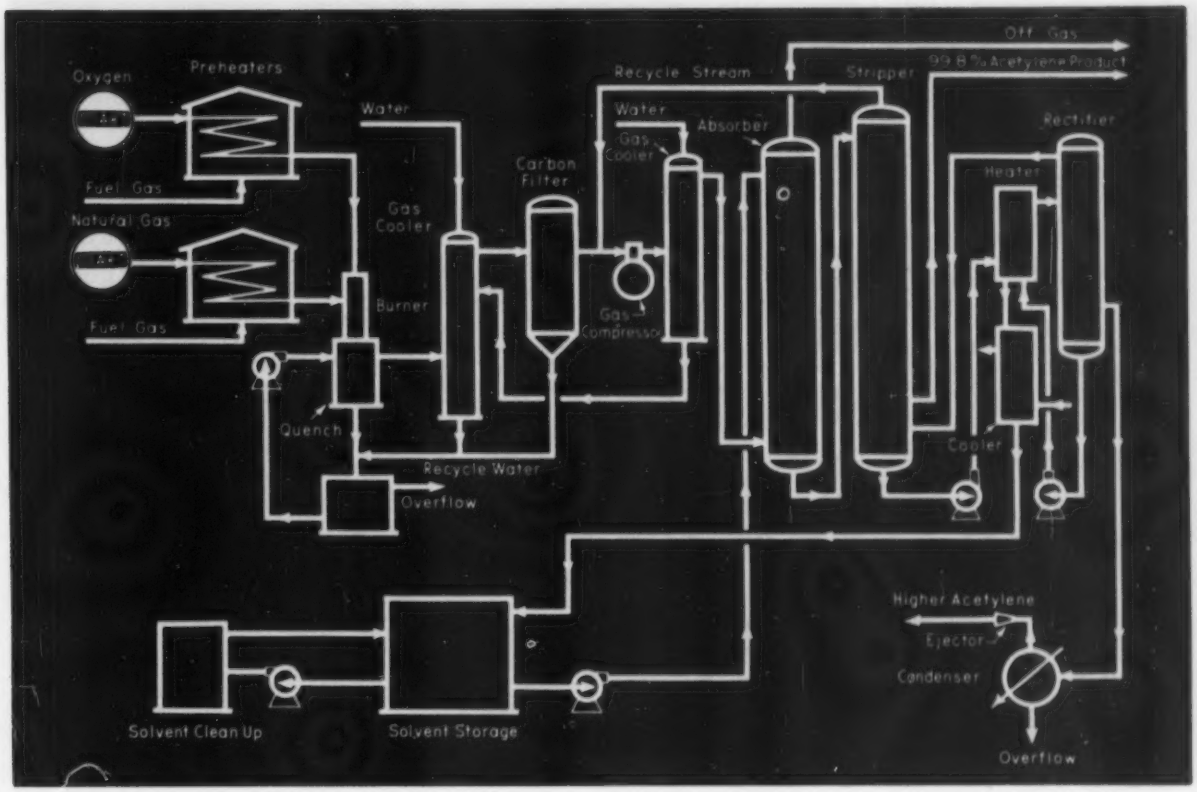
Butadiene Expansion—To meet these increasing demands, similar expansion planning is going forward in the butadiene segment of the industry. At the time of transfer of the rubber facilities to private operation, 549,000 ST of petroleum butadiene and 80,000 ST of alcohol butadiene capacity were sold. Another 100,000 tons of alcohol butadiene capacity was leased. Including the 50,000 ST of private butadiene existing at that time, the aggregate potential capacity totals about 780,000 ST. Expansions contemplated in these facilities by the end of 1958, combined with four new groups intending to enter the field, should bring the available butadiene capacity total to 1,200,000 ST, plus or minus 100,000 ST.

Because of the future advantageous pricing and availability of butanes over butylenes, an increasing percentage of petroleum butadiene will be derived from this source. Whereas 25 per cent of petroleum butadiene was derived from butane during the rubber program, this figure could be expected to be close to 50 per cent of the production facilities operating in 1957.

Transfer of stewardship of the vast rubber-producing facilities from federal to private control commanded international interest. The eyes of the world were closely surveying how the responsibilities would be discharged of providing good quality, fair priced rubber, carrying on necessary development to insure the industry's growth in the face of competing materials and finally providing expansion monies to insure stable world markets.

From the excellent start which has been made, it seems assured that in meeting this continuing challenge, the industry will grow and prosper making it a vital force in both the national and world economy. ##

* The new term "net polymer," which excludes oil content, is introduced here as a suggestion to define "in balance" polymerization and drying capacity as it was sold by the Government. Recent private expansions have been announced, with attendant confusion, on both a "net polymer" and a "net rubber" basis—the latter term including oil content. The term "gross rubber" is "net rubber" plus carbon black.



Acetylene (BASF)

Application: A process for making acetylene.

Charge: Natural gas containing 90-95 percent methane; oxygen, 90-95 percent purity.

Product: Acetylene of 99 percent purity.

Description: Oxygen and natural gas are preheated separately in direct-fired heaters to about 950 F. The charge gases are mixed in a molar ratio of 0.65:1.00 oxygen:methane upon being fed to the converter. The converter is a vertical cylindrical unit comprising three sections: mixing chamber, flame room, and quench chamber. The mixing chamber is specially designed to provide rapid yet thorough mixing of oxygen and methane.

The mixed gases are fed through a plurality of ports to the flame room. Careful control is necessary to prevent backtravel or blowoff. In the flame, methane is cracked according to the endothermic reaction:

$$2CH_4 \rightarrow C_2H_2 + 3\,H_2$$

The endothermic combustion of methane supplies sensible and cracking heats. About one-third of the entering methane is cracked; most of the remainder is burned. Over-all conversion of methane is 90-95 percent; conversion of oxygen is complete. The flame reaches an average temperature of 2700 F. Operating pressure is slightly above atmospheric. Residence time is 0.001-0.01 seconds.

The acetylene is cooled rapidly by a series of sprays located in the lower part of the converter. The cooled gases pass directly to a spray chamber where most of the water is condensed. The gases leave the chamber at 100 F. and have the following typical composition (dry basis):

Acetylene	8.5 percent
Hydrogen	56.0 percent
Carbon monoxide	25.0 percent
Carbon dioxide	3.5 percent
Methane	6.5 percent
Higher Acetylenes	0.5 percent
Total	100.0 percent

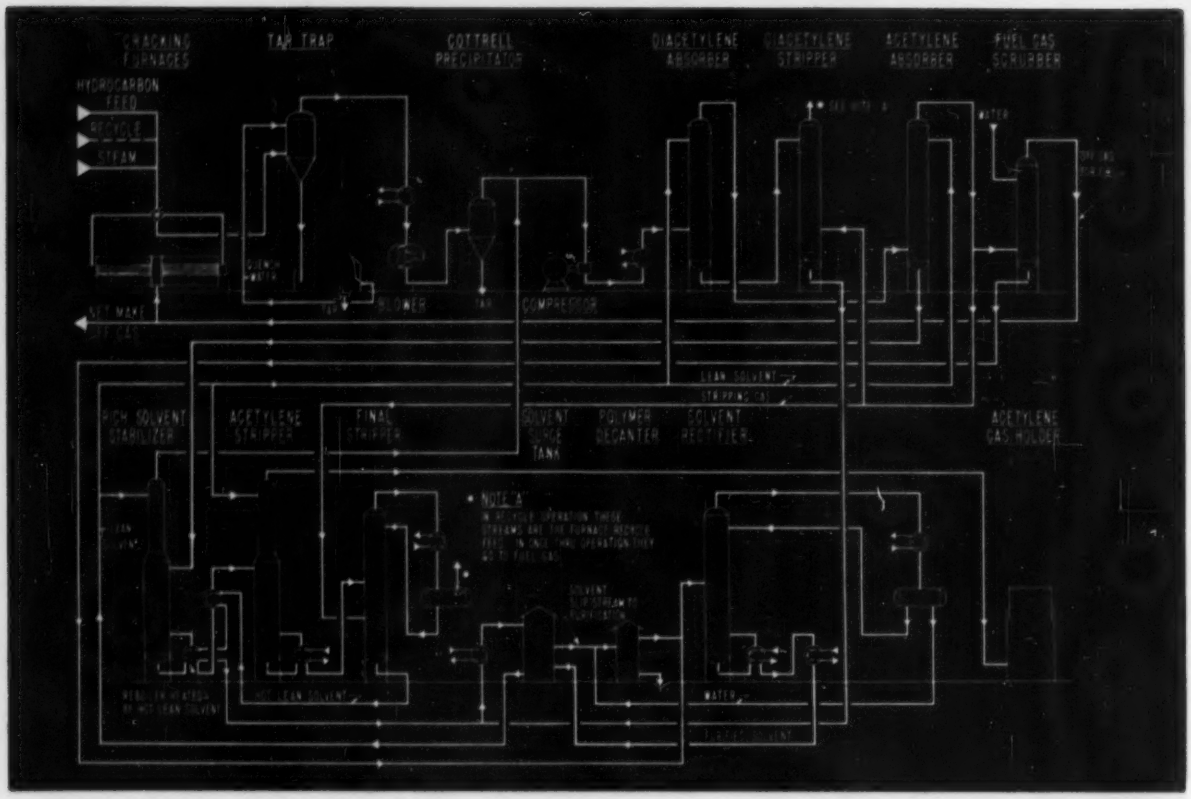
Before the cracked gas can be compressed and separated, residual soot must be removed. The clean cracked gas is then compressed to the head pressure (150 psig) of the concentration system.

The cracked gas is first scrubbed with a paraffinic oil to remove the very dangerous higher acetylenes. Any acetylene also removed is recovered in a pre-stripping operation. The cracked gas passes from the oil scrubber to the main absorber, where acetylene is removed by a selective solvent such as dimethyl formamide. This material shows a high acetylene: carbon dioxide selectivity, and therefore only a flashing operation is required to remove residual CO_2 from the rich solvent. Acetylene is ultimately stripped from the solvent in a conventional fractionator operating under reduced pressure. The product acetylene has a purity of 99 percent with major impurities being methylacetylene and carbon dioxide.

Yields: The over-all process yield of acetylene, based on carbon in the natural gas, is 30 percent.

Commercial Installations: This process or a variation is used by Carbide and Carbon Chemicals Company, Texas City, Texas; Monsanto Chemical Company, Texas City, Texas; American Cynamide Company, Fortier, La. (under construction).

Reference: Petroleum Refiner, Dec.'54,p160.



Acetylene (Wulff)

THE FLUOR CORPORATION LTD.

Application: A process for manufacturing acetylene.

Charge: Natural gas, ethane, or propane. The primary requirement is that the feed must be a vaporizable hydrocarbon.

Product: Acetylene of high purity.

Description: Acetylene is made by the cracking of natural gas, ethane, or propane. Multiple furnaces in parallel are used to provide continuous flow of "cracked gas." At any given time a mixture of feed vapor and dilution steam flows to one-half of the total number of furnaces, while air and fuel gas for heating flow to the other furnaces. Each furnace is reversed approximately every 60 seconds.

Flue gas effluent from the heating step is exhausted to the atmosphere. Cracked gas effluent from the furnaces is cooled by direct contact with water to condense and scrub out tars (no carbon black is produced). It is then compressed to atmospheric pressure, flows through a Cottrell precipitator for final cleanup, and is compressed to recovery-system pressure in the main compressors.

The recovery and purification section uses a high-boiling solvent (300-400 F.), such as acetonyl acetone or dimethyl formamide for absorption and separation of the acetylene. The compressed gas flows to the diacetylene absorber where the bulk of the diacetylene contaminant is removed. Solvent from the absorber flows to the diacetylene stripper where these contaminants are stripped out. The stripped solvent returns to the lean solvent surge tank.

The main gas stream flows from the diacetylene absorber to the acetylene absorber where it is contacted with lean solvent. Residue gas from this absorber is divided. Small portions of it are used for stripping in the diacetylene stripper and final stripper. The major portion is scrubbed with water to recover vaporized solvent and flows to the main fuel-gas system.

Rich solvent from the acetylene absorber flows to the rich solvent stabilizer. In this column ethylene, carbon dioxide, methane, hydrogen and other constituents more volatile than acetylene are taken overhead. These are then recycled through the main compressors to the acetylene absorber where they are eventually rejected.

Rich solvent flows from the bottom of the rich solvent stabilizer to the acetylene stripper where the acetylene product is taken overhead to storage, while methylacetylene and other less volatile constituents are retained in the bottoms. This solvent stream then flows to the final stripper where these higher homologs of acetylene are removed by stripping with residue gas.

To remove polymer from the solvent, a small slip-stream of the lean solvent is withdrawn, diluted with water, decanted, and the polymer withdrawn. The solvent joins the bottoms from the fuel gas scrubber and is dried by distillation. The purified solvent is returned to the system.

Where feed has an unusually high value, the raw-feed requirements and production of residue gas may be minimized by recycling a portion of the residue gas to the furnace. For such a "recycle" operation, the recycle stream is made up of the gas from the diacetylene stripper and the final stripper.

Operating Conditions: The operating temperature reaches a peak of 2200-2500 F. with the pressure at 15 inches of Hg absolute. The total time the gases are in the furnace is in the order of 0.1 second.

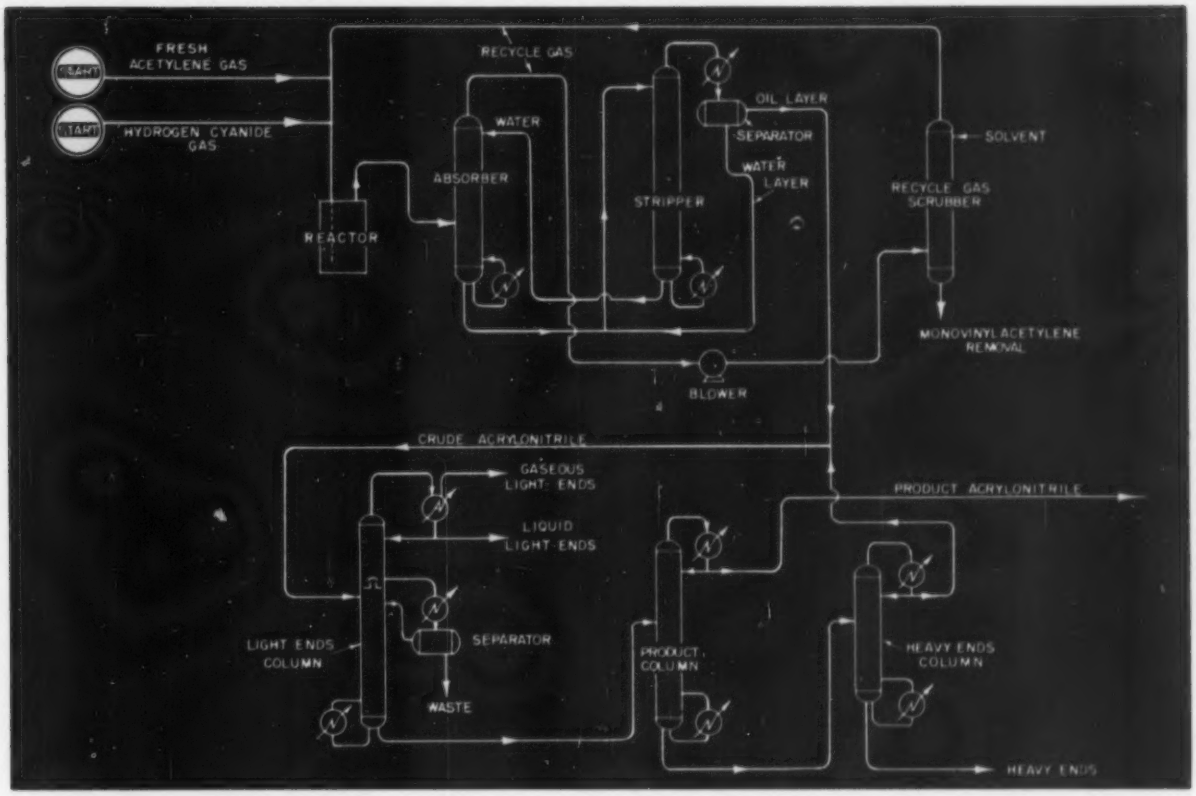
Yields: Typical yields when operating on the various types of feed are shown in the table below:

	FEED MATERIAL		
	Natural Gas	Ethane	Propane
Percent feed converted to acetylene*	21.8	48.6	38.4
Lbs. acetylene recovered per 100 lb. feed	16.2	37.9	30.7

*Conversion is percent of carbon in feed which appears as carbon in furnace effluent acetylene.

Commercial Installations: A small commercial demonstration plant has been in operation at Maywood, Calif. by Wulff Process Co. since 1951.

Reference: PETROLEUM REFINER, Sept.'53,p162.



Acrylonitrile

Application: A process for manufacturing acrylonitrile from acetylene and hydrogen cyanide.

Charge: Acetylene gas (99 percent purity); hydrogen cyanide gas (99+ percent purity).

Product: Acrylonitrile liquid of 99.5 percent purity.

Description: Acrylonitrile may be produced either by the dehydration of ethylene cyanohydrin or by the direct combination of acetylene and hydrogen cyanide. The latter method is known as the "natural gas process." It is the more important method today, commercially, and accordingly will be described here.

Acetylene and hydrogen cyanide in a ratio of 10:1 form the reactor charge. The reactor is a rubber-lined cylindrical vessel containing liquid catalyst to a depth of several feet. The reactants are injected separately under the liquid surface. About 10 percent of the acetylene is converted, and this consumes practically all of the hydrogen cyanide.

The aqueous catalyst consists of cuprous chloride, hydrogen chloride, and alkali chlorides in 36 weight percent water. All salts are in solution at 175 F. which is also the reaction temperature. Yields of 1.0-1.5 pounds of acrylonitrile per hour-foot^3 of solution are obtained. The catalyst life is 1-2 months and must be regenerated.

The reaction pressure is slightly above atmospheric.

The reaction products pass to an absorber, the lean gas from which contains acetylene and divinylacetylene. The latter constituent is removed in a separate scrubbing operation. The residual acetylene is recycled through a blower to the reactor charge.

The absorber is operated at a water rate such that a two percent acrylonitrile solution is withdrawn as bottoms. This stream is sent to the stripper, from which a crude acrylonitrile-water azeotrope is taken overhead. The water layer from the separated azeotrope is recycled to the stripper feed. The oil layer, or "crude acrylonitrile," is sent to a distillation train for separation and purification.

The concentration of acrylonitrile in the crude solution is about 80 weight percent; that of the other materials is four weight percent or less.

The first tower in the distillation train (light ends column) enables the overhead removal of materials boiling below acrylonitrile. Acetylene and monovinylacetylene pass off as gases.

Product acrylonitrile, having a purity of about 99.5 percent on a dry basis, is removed as overhead from the second column. The operating head pressure is about 140 mm Hg abs. The bottoms stream contains heavy ends plus a significant amount of acrylonitrile.

The third tower in the train, the heavy ends column, serves to recover acrylonitrile from the product column bottoms. The heavy ends column operates at a head pressure of 120-150 mm Hg abs. The recovered acrylonitrile is not specification-grade and must be recycled to the light ends column.

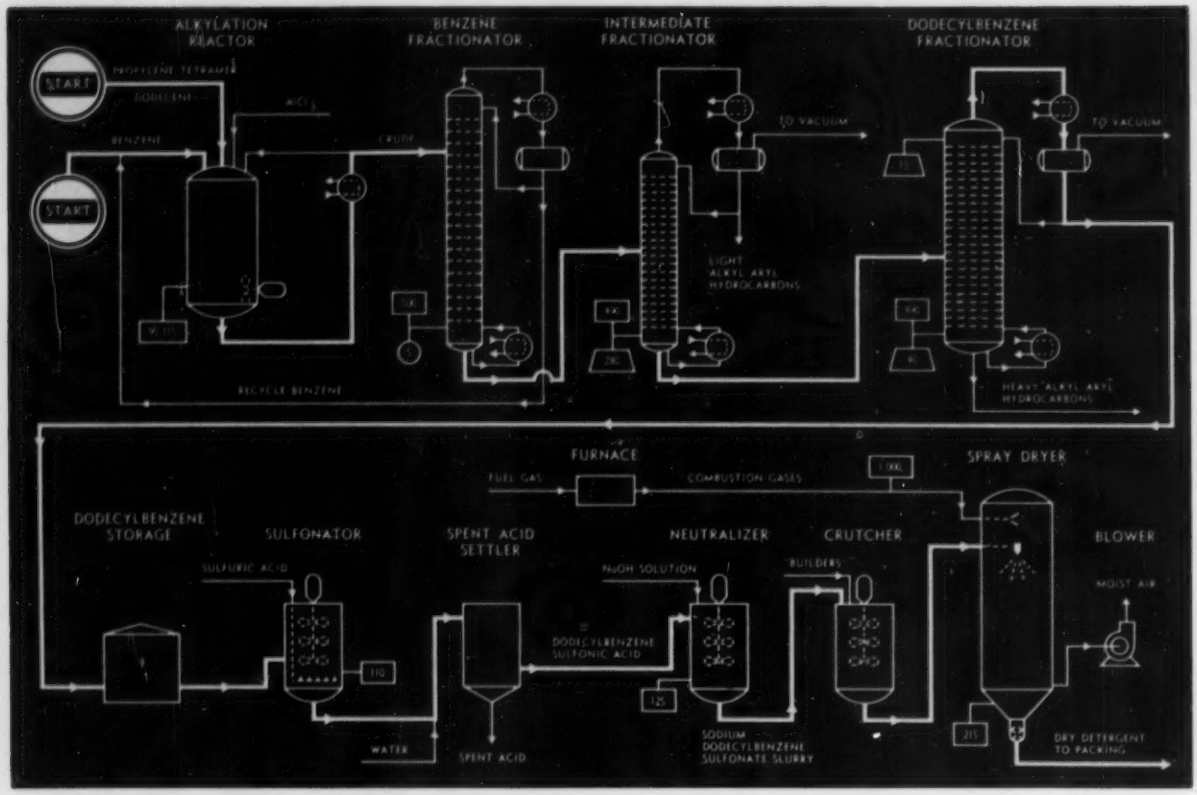
The product acrylonitrile has a boiling range of 169-173 F.

Operating Conditions: The important operating conditions are those in the reactor. They are defined in the above text.

Yields: Typical over-all process yields are:
Acrylonitrile from HCN, 85 percent.
Acrylonitrile from C_2H_2, 75 percent.

Commercial Installations: Plants utilizing the methane process are: Monsanto Chemical Company, Texas City, Texas; American Cyanamid Company, Fortier La. (under construction); The B. F. Goodrich Company, Calvert City, Ky. (announced).

References: "The Manufacture of Acrylonitrile From Natural Gas," J. T. Thurston, E. L. Carpenter, and F. Derbenwick of American Cyanamid Co., Fourth World Petroleum Congress, Rome, Italy.



Alkyl Aryl Sulfonates

CONTINENTAL OIL COMPANY

Application: A process for the manufacture of dodecylbenzene sulfonate synthetic detergents.

Charge: Benzene, dodecene (propylene tetramer), sulfuric acid, caustic soda, and "builders."

Product: Finished detergent containing 15 to 40 percent sodium dodecylbenzene sulfonate.

Description: This process involves reaction of dodecene with benzene in the presence of aluminum chloride catalyst; fractionation of the resulting crude mixture to recover the desired boiling range dodecylbenzene; sulfonation of the dodecylbenzene and subsequent neutralization of the sulfonic acid with caustic soda; blending the resulting slurry with chemical "builders"; and drying.

Dodecene (350-420 F. boiling range) is charged into a reaction vessel containing benzene and aluminum chloride. The reaction mixture is agitated and circulated through an external cooler to maintain the reaction temperature at about 115 F. maximum. An excess of benzene is used to suppress the formation of by-products. Aluminum chloride requirement is 5-10 weight percent of dodecene. The reaction may be carried out using hydrofluoric acid or sulfuric acid in place of aluminum chloride.

After removal of aluminum chloride sludge, the reaction mixture is fractionated to recover excess benzene which is recycled to the reaction, a light alkylaryl hydrocarbon, dodecylbenzene, and a heavy alkylaryl hydrocarbon. The dodecylbenzene is a water-white liquid having a boiling range of 530-600 F.

Sulfonation of the dodecylbenzene may be carried out continuously or batch-wise under a variety of operating conditions using sulfuric acid (100 percent), oleum (usually 20 percent SO_3) or anhydrous sulfur trioxide. The optimum sulfonation temperature is usually in the range of 100-140 F. depending on the strength of acid employed, mechanical design of the equipment, etc. Removal of spent sulfuric acid from the sulfonic acid is facilitated by adding water to reduce the sulfuric acid strength to about 78 percent. When anhydrous sulfur trioxide is the sulfonating agent, there is no spent acid removal problem and the sulfonic acid is ready for further processing immediately after sulfonation.

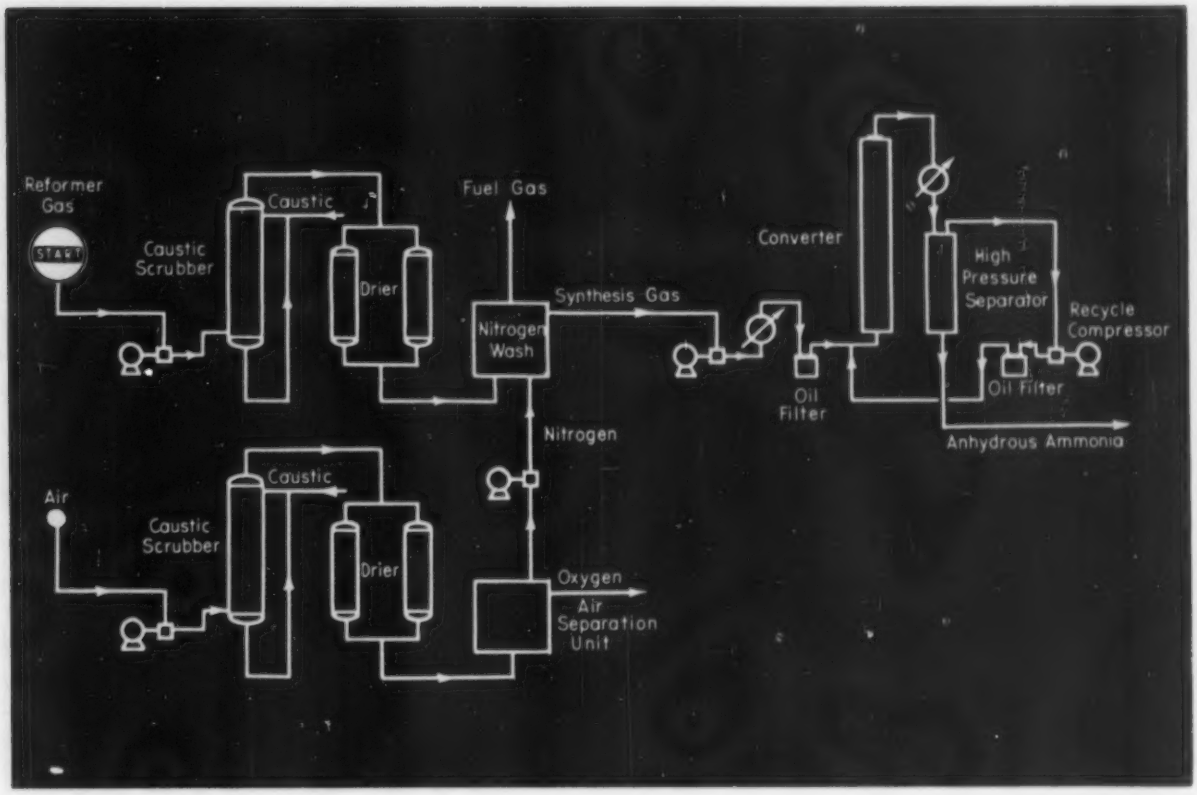
The sulfonic acid is neutralized with 20-50 percent caustic soda solution to a pH of 8 at a temperature of about 125 F. Chemical "builders" such as trisodium phosphate, tetrasodium pyrophosphate, sodium silicate, sodium chloride, sodium sulfate, carboxymethyl cellulose, etc., are added to enhance the detersive, wetting or other properties desired in the finished product. A flaked dried product is obtained by drum drying, or a bead product is obtained by spray drying.

Operating Conditions: Refer to the above text and flow diagram.

Yields: Alkylation, 75 percent; sulfonation, substantially 100 percent; drying, 95 percent or greater.

Commercial Installations: Continental Oil Company, Baltimore, Md., and Chicago; Atlantic Refining Company, Philadelphia, Pa.; Oronite Chemical Company, Richmond, Calif.; Monsanto Chemical Company, St. Louis, Mo., and Standard Oil Company of Indiana, Whiting, Ind.

References: Petroleum Refiner, July, 1954, p. 157; *Ind. Eng. Chem.*, **46**, 1925 (1954); *Ind. Eng. Chem.*, **46**, 248 (1954); *J. Am. Oil Chemists' Soc.*, **31**, 200 (1954).



Ammonia

THE FLUOR CORPORATION LTD.

Application: A process for manufacturing ammonia.

Charge: Catalytic Reformer Off-Gas.

Product: Liquid Anhydrous Ammonia.

Description: Briefly, the complete process scheme involves the following steps: (1) Separation of air into nitrogen and oxygen; (2) purification of the hydrogen; and (3) synthesis of ammonia from the hydrogen and nitrogen mixture.

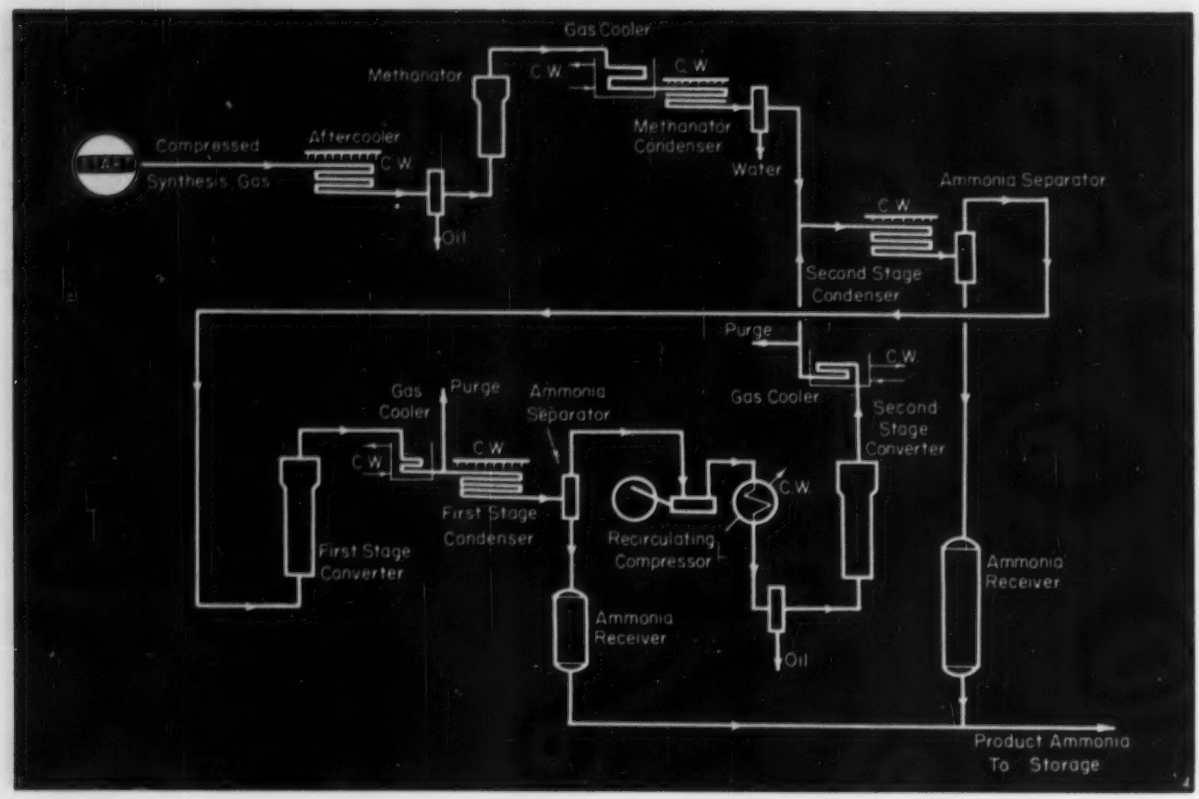
As shown in diagram, air is compressed, scrubbed with caustic for carbon dioxide removal and then dried. The air is separated by liquefaction and distillation into nitrogen of 99.99 percent purity and oxygen of 85 percent purity. This oxygen is available as a by-product but in this presentation is treated as a waste gas. A high hydrogen-content catalytic reformer off-gas such as may be obtained from a fixed-bed, nonregenerable platinum-catalyst unit has been assumed as feed. The assumed analysis is hydrogen, 93.0 and hydrocarbons, 7.0 vol. percent. The gross heating value is 490 BTU/std. cubic feet. In view of the high hydrogen-concentration and low acid-gas concentration, the purification of this reformer gas is very easily accomplished by a light caustic scrub, low temperature condensation of most of the hydrocarbons and the nitrogen wash to remove traces of methane and any carbon monoxide. Part of the synthesis nitrogen is supplied by vaporization of liquid nitrogen in the nitrogen wash unit. Additional nitrogen from the air separation unit is added to the hydrogen to make the synthesis-gas mixture.

The synthesis-gas mixture consists of 3 parts hydrogen, 1 part nitrogen, about 100 ppm inerts, and less than 20 ppm total oxygen-containing impurities. The synthesis-gas mixture is compressed to about 600 atm. and filtered for oil removal. It is very important that all of the oil be removed from the synthesis gas stream before it goes to the ammonia converter. The oil, if not removed, can contaminate the catalyst and reduce its life. The activity of the catalyst is reduced rather rapidly by poisons carried over in the compressor lube oil. At the inlet to the ammonia converter, the fresh feed is joined by a recycle stream of unconverted hydrogen and nitrogen. The combined feed stream is heated inside the ammonia converter by heat exchange with product gases. The hot hydrogen-nitrogen mixture passes through a bed of promoted iron catalyst, where conversion to ammonia occurs. Effluent gases from the converter are cooled by exchange with water, and product ammonia is condensed and separated from the unconverted gases in a high-pressure separator. The ammonia is sent directly to storage and the hydrogen and nitrogen are recycled by means of the recycle compressor.

Operating Conditions: The synthesis converter operates at about 600 atmospheres.

Commercial Installations: Several units of this type are under construction.

References: PETROLEUM REFINER, Dec.'54,p156 and May'55,p145.



Ammonia (Claude Process)

Application: The Claude process for the manufacture of ammonia.

Charge: Synthesis gas—approximately 75 mole percent hydrogen, 25 mole percent nitrogen.

Product: Technical grade ammonia (99.5 percent purity).

Description: The synthesis gas is compressed to 15,000 psi, cooled to ambient temperature, and passed through a separator for removal of compressor lubricating oil. It is then charged to the methanator reactor, where carbon monoxide is converted according to the reaction

$$CO + 3H_2 = CH_4 + H_2O$$

A reduced iron catalyst (previously used in the ammonia converters) is used. The methanator reactor is a steel vessel containing a catalyst basket and means for internal heat exchange between inlet and exit gases. Typical operating conditions are: pressure, 15,000 psi; temperature in reaction zone, 730-930 F. (depending on age of catalyst); vapor space velocity, 60,000 $hr.^{-1}$ Catalyst life is on the order of six months.

The methanator effluent is cooled from 300 F. to ambient temperature, which causes condensation of water and small amounts of methanol and methylamine produced in the methanator. These materials are removed in a separator, and the gas is then ready for admission to the synthesis loop. It contains hydrogen and nitrogen in a 3.0:1.0 ratio, and some 2.0-2.5 percent inert gases.

The synthesis loop comprises two ammonia converters with attendant condensers and separators, a reciprocating compressor for circulating the gases around the loop, and a purge system for controlling the level of inerts.

The fresh synthesis gas from the methanator is introduced downstream of the second-stage ammonia converter (other points of introduction can be used) before the gases from that converter have been cooled. The mixture passes to a water-cooled condenser where some 60 percent of the ammonia present is condensed. The condensate is trapped out to low pressure receivers and ultimately finds its way to product ammonia storage. The non-condensed material comprises the feed to the first-stage ammonia converter.

The first-stage converter is a specially-designed vessel with steel shell and closure, and certain internals of high-nickel alloy. The catalyst is a special magnetic iron oxide, doubly promoted with aluminum and potassium oxides, and reduced *in situ*. The gases make several passes through the internals for the double purpose of keeping the outer shell cool and exchanging heat between products and reactants. Electric heating coils are provided for starting up the converter. The catalyst basket is designed for convenient removal from the reactor shell, since the catalyst life is on the order of 2-3 months.

Typical operating conditions for the first-stage converter are: pressure, 14,500-14,700 psi; temperature in reaction zone, 900-1100 F. (depending on age of catalyst); vapor space velocity, 44,000 $hr.^{-1}$; and conversion per pass, 40 percent. The exit gas from the converter has a temperature of 300-350 F.

About 80 percent of the ammonia in the exit gas is condensed in a water-cooled exchanger, and trapped out to product storage. The uncondensed material passes to the recirculating compressor where the pressure is boosted by 500-1000 psi. The discharge gas is cooled, oil is removed, and the gas fed to the second-stage converter.

The second-stage converter is similar in design to the first-stage unit, and operates under the following conditions: pressure, 15,000-15,500 psi; temperature in reaction zone, 900-1100 F. (depending on catalyst age); vapor space velocity, 30,000 $hr.^{-1}$; conversion per pass, 40 percent. The exit gas, at a temperature of 280-330 F., is mixed with fresh synthesis gas and the cycle repeated.

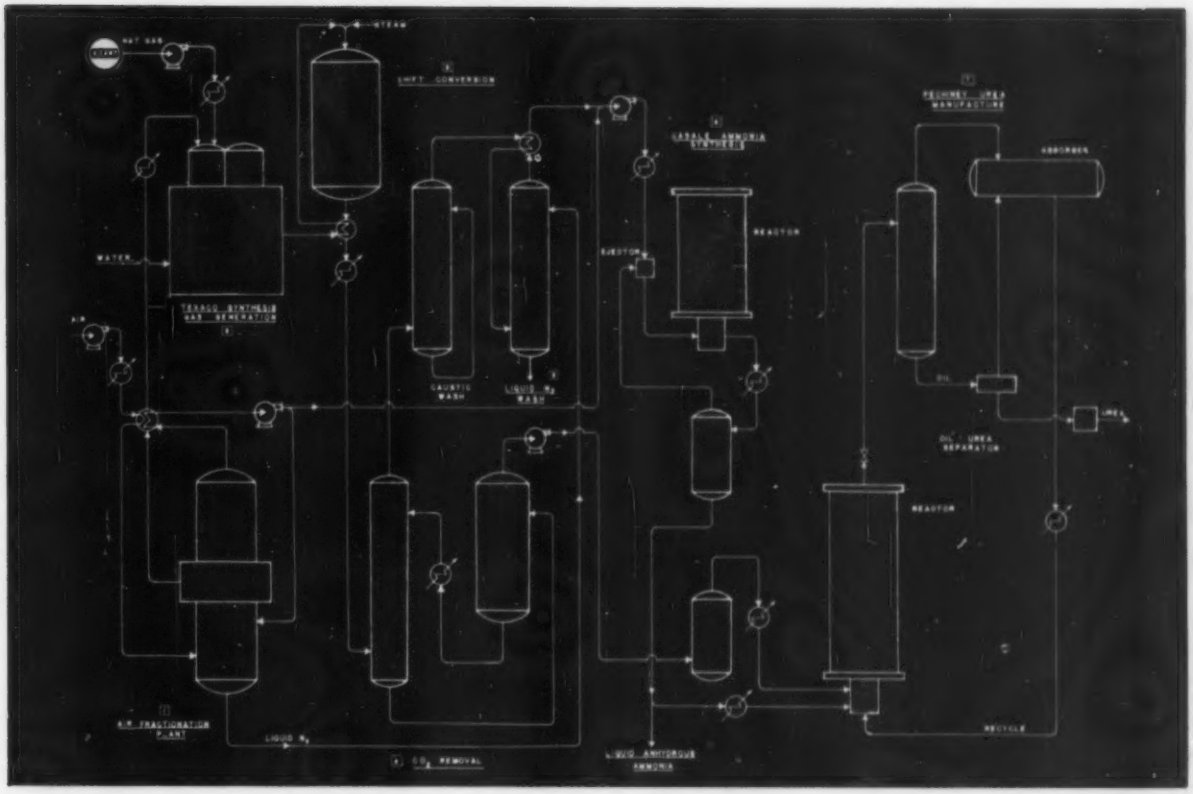
A buildup of inert gases is prevented by bleeding off a portion of the exit gases from the converters.

The condensed ammonia from the converter exit streams is depressured and stored in steel spheres at about 55 psig and 38 F.

Yield: Over-all process yield, ammonia from synthesis gas, is 85-87 percent.

Commercial Installations: This process is used at the following plants: Hercules Powder Co., Pinole, Calif.; Mississippi Chemical Corp., Yazoo City, Miss.; Mississippi River Fuel Corp., Crystal City, Mo.; San Jacinto Chemical Co., Houston.

References: Thompson, H. L., P. Guillaumeron and N. C. Updegraff, *Chem. Eng. Progr.*, 48,468(1952).



Ammonia and Urea

FOSTER WHEELER CORPORATION

Application: This is the Casale process for the manufacture of ammonia and the Pechiney urea process.

Charge: The charge is natural gas and air.

Products: High purity ammonia and urea.

Description: The process consists of these stages: (1) air fractionation, (2) synthesis gas generation, (3) shift conversion, (4) carbon dioxide removal, (5) liquid nitrogen wash, (6) ammonia synthesis and (7) urea manufacture.

Air, filtered and caustic scrubbed, is compressed to about 600 psig, liquefied and separated into nitrogen and oxygen in a liquid air plant. The liquid oxygen is pumped through vaporizers to The Texaco Development Corporation synthesis gas generators at 400 psig. The liquid nitrogen is used in step (5) and (6). "Third paragraph" Preheated natural and oxygen at about 400 psig enters the generator through a special mixing burner. The products, carbon monoxide and hydrogen, are quenched and shifted in the shift converter, the carbon monoxide shifting to carbon dioxide and hydrogen with steam and a catalyst. The synthesis gas generator requires no catalyst.

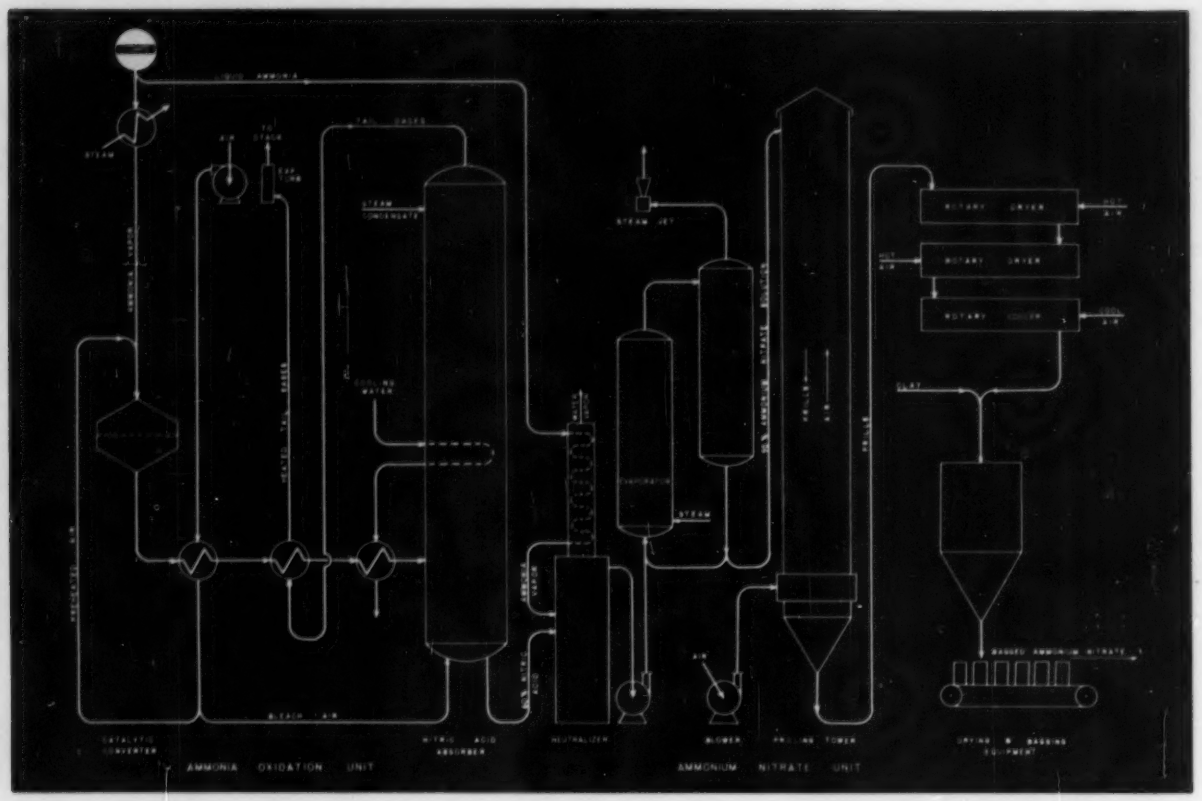
Carbon dioxide is removed by absorption from the gas stream with MEA (mono-ethanol-amine). The carbon dioxide is then stripped from the solvent.

The synthesis gas is then caustic washed and dried before entering the liquid nitrogen wash system. Here, essentially all gases except hydrogen are condensed out of the stream.

The gas stream then is mixed with enough nitrogen to establish molecular proportions and is fed to the Casale ammonia synthesis step. This gaseous mixture of hydrogen and nitrogen is compressed to approximately 9000 to 12,000 psig (as conditions indicate), is cooled to about 100 F., and enters the reactor via the jet ejector system where ammonia is formed over a catalyst. The effluent gases are cooled, and then liquid is separated from gases. The unconverted gases are recirculated, and liquid anhydrous ammonia moves to storage or to the Pechiney urea production plant.

In the Pechiney process, the liquid anhydrous ammonia is pumped up to the pressure of the reaction system, 2900 psig, is heated to approximately 300 F., and joins the carbon dioxide entering the Pechiney reactor. The carbon dioxide has also been compressed to 2900 psig and preheated to about 500 F. In the reactor there is also present a circulating neutral oil containing recycle ammonium carbamate in the form of a finely dispersed solid or slurry. The urea-carbamate-oil mixture leaves the reactor and its pressure is reduced to 60 psig. In a liquid-vapor separating vessel the oil in slurry form is mixed with an aqueous solution of urea (the water is a product of the reaction) and is pumped from the bottom for liquid-liquid separation of the oil and the urea solution. The urea solution is concentrated and finished for the production of urea in solid form. The unconverted carbamate is recycled to the reactor as oil-carbamate slurry.

References: PETROLEUM REFINER, Sept.'53,p178; *Chemical Engineering*, May'54,p332.



Ammonium Nitrate

THE GIRDLER COMPANY

Application: A process for manufacturing fertilizer grade ammonium nitrate.

Charge: Anhydrous liquid ammonia.

Product: Prilled ammonium nitrate with a nitrogen content of 33.5 weight percent.

Description: First, ammonia is oxidized with air to produce oxides of nitrogen which are then absorbed in water to form nitric acid. The reactions may be written as follows:

$$4\,NH_3 + 5\,O_2 = 4\,NO + 6\,H_2O$$
$$2\,NO + O_2 = 2\,NO_2$$
$$3\,NO_2 + H_2O = 2\,HNO_3 + NO$$

Ammonium nitrate is then formed by the reaction of nitric acid with ammonia as follows:

$$NH_3 + HNO_3 = NH_4NO_3$$

The duPont process ammonia oxidation unit is shown. Anhydrous liquid ammonia is first vaporized and then mixed with clean, compressed air and passed over a platinum gauze catalyst at 100-psig pressure. This catalyst is contained in the converter and, as the reaction is highly exothermic, requires water cooling.

The hot gas emerging from the converter is cooled by heat exchange. The cooled gas then goes to an absorber tower where steam condensate is used for absorption. A secondary oxidation reaction occurs in the tower with the bleaching air which is introduced to the absorber. The nitric acid produced passes through the bleach tray where oxides of nitrogen are stripped from the acid.

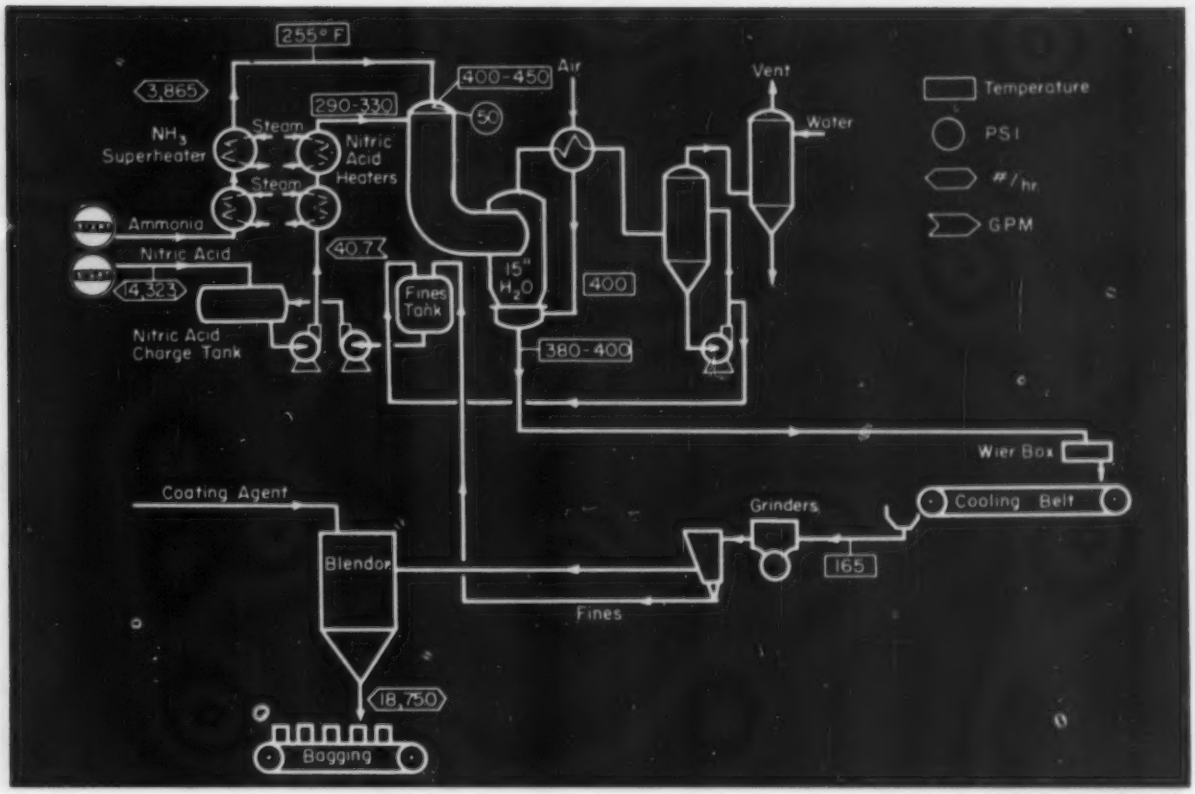
In the production of ammonium nitrate, the ammonia, as a vapor, and nitric acid streams are metered and controlled individually to give as close neutralization as possible. Under normal operation a solution of 83 to 85 percent ammonium nitrate may be attained by allowing the heat of reaction to evaporate the excess water. The solution then goes to a storage tank.

Before solidification the solution is pumped to a vacuum evaporator where it is concentrated to about 95 percent ammonium nitrate. The prilling process for solidification is that of Canadian Patents and Development, Ltd. The 95 percent solution is pumped to the top of the prilling tower and sprayed countercurrent to an updraft of air. The free fall distance in the tower is greater than 100 feet. A wet granular salt is formed. Little or no moisture is lost in this process and the salt still has about 5 percent water.

The wet salt is dried in rotary kiln-type dryers. The salt then passes through a cooler using unheated air. At this point the moisture content is about 0.1 percent. The ammonium nitrate is mixed with four weight percent clay to prevent caking during storage.

Yields: The over-all yield of ammonia to ammonium nitrate is about 95 percent. This amounts to about 2.25 tons fertilizer per ton ammonia feed.

Commercial Installations: The first Girdler plant started operation for Mississippi Chemical Company, Yazoo City, Miss., in 1951. It has a capacity of 140 tons per day. A second installation, with a capacity of 330 tons per day, has been placed in operation for Cooperative Farm Chemicals Association, Lawrence, Kan.



Ammonium Nitrate (Stengel Process) COMMERCIAL SOLVENTS CORPORATION

Application: A process for manufacturing fertilizer grade ammonium nitrate.

Charge: Anhydrous ammonia and nitric acid.

Product: Flaked ammonium nitrate.

Description: The Stengel process produces molten or dissolved ammonium nitrate of any desired concentration. No further concentration or evaporation is required for either prilling, graining or flaking. The process is not dangerous as there is no large amount of molten ammonium nitrate in the reactor at any one time and this is blanketed with steam until it enters the weir box.

Liquid anhydrous ammonia is vaporized and superheated to 225 F. and introduced along with nitric acid (containing ammonium nitrate fines, dissolved) at 290-330 F. into the top of the packed reactor. The reaction proceeds as follows:

$$NH_3 + HNO_3 \rightarrow NH_4NO_3 + 20{,}600 \text{ cal.}$$

This reaction product passes to a separator where heated air is introduced to reduce the water content and the molten ammonium nitrate is removed from the bottom. Before the air is introduced to the reactor it is heated to 400 F. by exchange with the separator overhead product and then introduced into the reactor in two different places. This air is blown up through the molten salt and carries with it water vapor. This process reduces the water content of the molten ammonium nitrate from about 2 percent to less than 0.2 percent. This air must be free from any oil or other carbonaceous matter since these materials make ammonium nitrate more susceptible to explosion.

The air leaving the stripper carries with it a small amount of entrained ammonium nitrate. To remove this, the air is scrubbed in a partial condenser to remove the ammonium nitrate and traces of ammonia. The concentrated liquor obtained from this scrubbing is recycled back to be used as solvent in the fines dissolving tank. The rate of recirculation of condensate in the partial condenser is controlled by the specific gravity of the concentrated liquor. The overhead from the partial condenser is scrubbed with water before venting to the atmosphere.

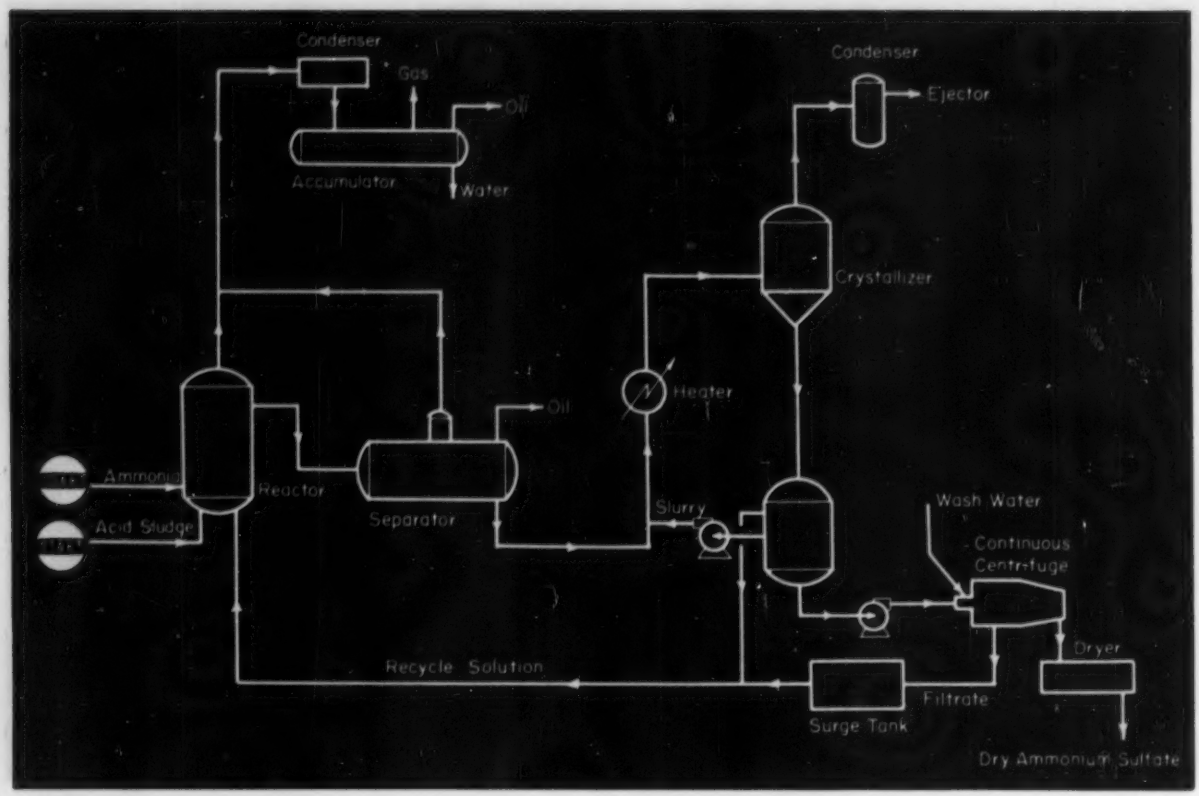
The molten ammonium nitrate product flows to a weir box and onto stainless steel cooling belts. The belts move over water and the molten ammonium nitrate solidifies. At the end of each belt the flake is broken up and goes to grinders and sizing equipment. The fines return to the nitric acid mixing tank.

The final product is coated with 3 pounds of diatomaceous earth for each 97 pounds of ammonium nitrate.

Yields: The over-all ammonia to ammonium nitrate is 100 percent.

Commercial Installations: Commercial Solvents Corporation, Sterlington, La.

References: Industrial and Engineering Chemistry, Vol.46,Apr.'54,p622.



Ammonium Sulfate

Application: This is a process for the manufacture of dry ammonium sulfate.

Charge: Sulfuric acid-oil sludge and ammonia are the charge materials.

Products: The products are dry ammonium sulfate and recovered oil.

Description: The process described here represents an economical method for the reduction of atmospheric pollution through the use of refinery waste streams in the manufacture of ammonium sulfate. Except for the source of the charge, this process differs very little from one that would utilize fresh acid.

Sulfuric acid refinery sludge and either commercial ammonia or waste ammonia from various refinery streams are charged to the reactor where they form ammonium sulfate in an aqueous solution. The oil and carbonaceous material in the sludge do not interfere with the reaction. The charge acid strength may be as high as 30 to 50 weight percent, but the acidity of the reactor product is maintained at 0.5 percent. This final concentration promotes good crystal growth and assures complete utilization of the ammonia.

The reactor operates at a pressure of approximately 7 psig and a temperature of 240 to 245 F. Higher temperatures cause increased corrosion. The vigorous heat of reaction induces thermal mixing. Dilute ammonium sulfate solution is recycled to the reactor to absorb the heat of reaction. The product stream overflows to a separator for separation of the oil and aqueous phases. The gas and vapor from the reactor and separator pass to a condenser and accumulator for separation into the respective non-condensible gas, oil and water streams.

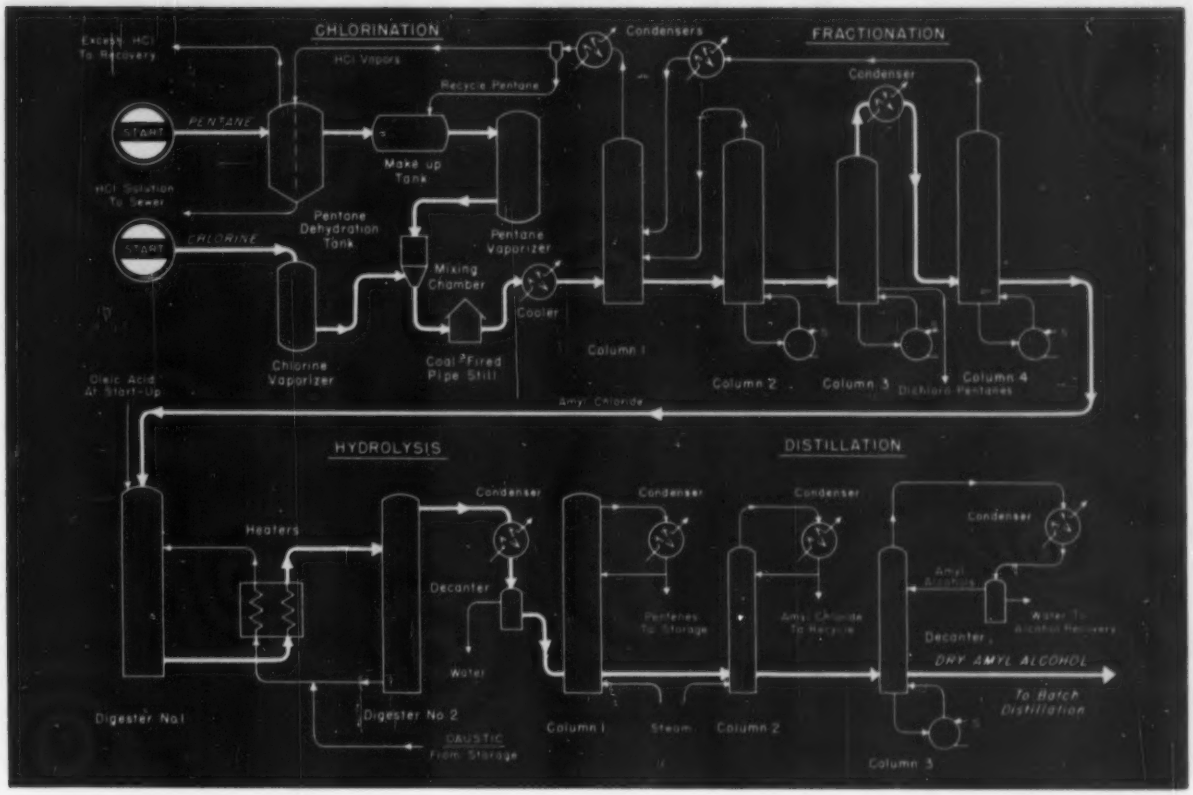
The solution from the separator is combined with a recycle ammonium sulfate slurry and charged to an evaporative crystallizer. Sufficient heat is added to maintain the crystallizer at the desired temperature. The solution is concentrated and the ammonium sulfate crystallized through evaporative cooling. A vacuum is maintained by an overhead condenser and jet ejector. Crystal growth is promoted by recycling slurry from the vessel below the barometric leg back to the crystallizer. Example conditions in the crystallizer are 150 F. with a pressure of 3 psia in the vapor space.

The slurry from the crystallizer is charged to a continuous centrifugal filter. The crystals are given a water wash by means of an internal wash line before they are discharged to the dryer. The filtrate liquor is recycled to the reactor. Saturated solution from the crystallizer may be added to the recycle filtrate for control purposes. The dryer reduces the water content of the crystalline ammonium sulfate to approximately 0.05 weight percent to prevent caking. The product is conveyed to storage bins through ducts by the use of dry air.

Operating Conditions: The principal operating conditions have been mentioned in the description above.

Yields: The yield of ammonium sulfate is approximately 95 weight percent, based on the acid in the sludge.

Commercial Installations: A variation of this process is employed by the General Petroleum Corporation at Torrence, Calif. Several other companies employ similar processes.



Amyl Alcohol

SHARPLES CHEMICAL DIVISION OF PENNSYLVANIA SALT MANUFACTURING COMPANY

Application: Continuous process for the manufacture of amyl alcohols.

Charge: Pentane, chlorine, caustic soda.

Product: Various grades of mixed amyl alcohols, including primary, secondary, and tertiary isomers.

Description: Pentane is dehydrated by contacting with anhydrous hydrogen chloride, which is a by-product of the chlorination step. The anhydrous pentane and chlorine are vaporized separately, and then mixed in such proportions that the mixture is not in the explosive range. This mixture, at a temperature of about 120° C. then goes to a pipe still where the chlorination reaction takes place. The reactants leave the pipe still at about 300° C. and are immediately sent to a cooler to suppress the formation of dichloropentanes.

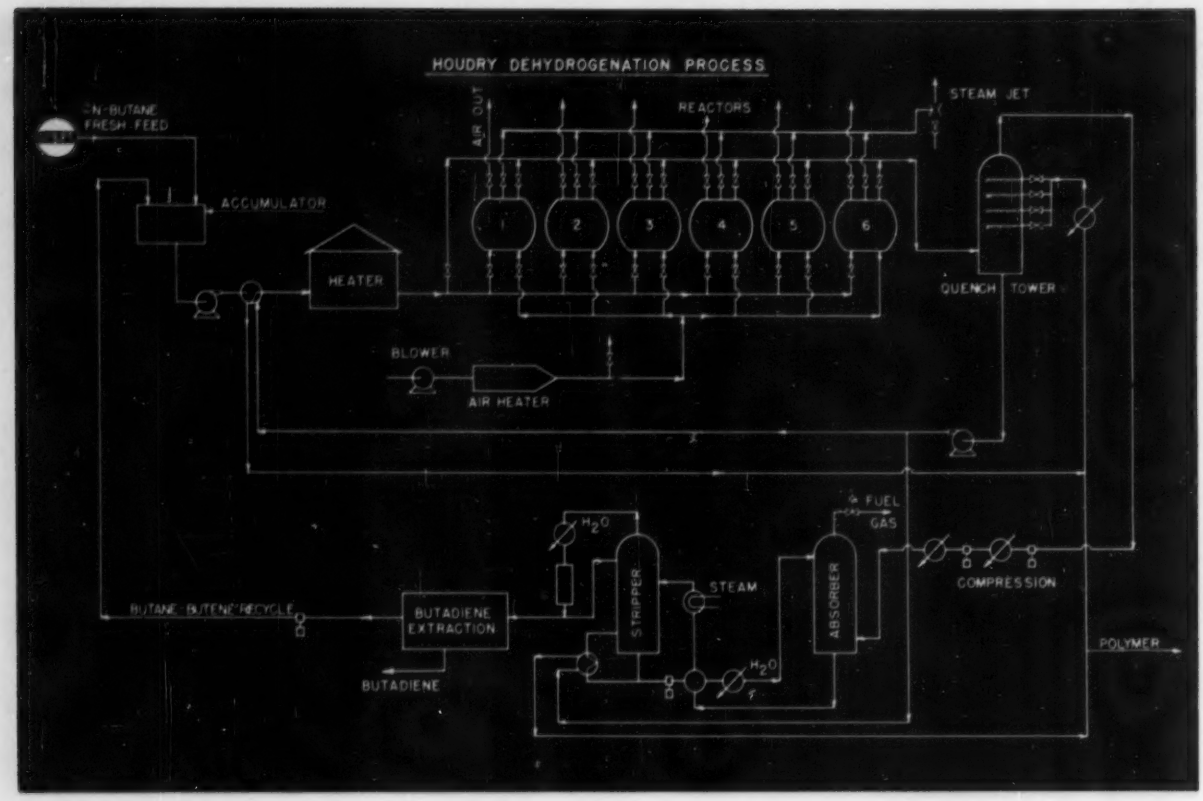
From the cooler the reaction mixture enters a fractionating column in which hydrogen chloride and pentane are removed overhead. The pentane is condensed and returned to the make-up tank. The hydrogen chloride is sent to the pentane dehydration tank where part of it reacts with the water in the pentane to form hydrochloric acid; the acid separates from the pentane and is periodically drained off to the sewer. The unreacted hydrogen chloride passes from the pentane dehydration tank to the recovery unit, where it is dissolved in water to form a commercial grade of hydrochloric acid.

The bottoms from the first column, consisting of amyl chloride, dichlorides, and some pentane, go to a second column, where the pentane is taken off overhead and recycled to the first column. The bottoms from the second column are sent to a third column where amyl chloride is taken off overhead, and dichloropentanes are removed as the bottom product. The amyl chloride then goes to a fourth column in which residual amounts of pentane are removed, and recycled to the first column.

The amyl chloride (a mixture of the primary, secondary, and tertiary isomers) is scrubbed with caustic to remove traces of hydrogen chloride, and is then fed to a digestor in which it is hydrolyzed to form amyl alcohol. Caustic soda is used as the hydrolyzing agent, and oleic acid as a catalyst. The mixture goes to a second digestor from which crude amyl alcohols are removed as a top product. Brine is formed as a by-product of the hydrolysis reaction, and is removed from the bottom of the second digestor.

The crude alcohol is condensed, and the water fraction removed by decantation. It then goes through a series of three columns in which amylenes (a by-product of the hydrolysis reaction), amyl chloride, and water are removed. The amylenes are used in the production of amylphenols in another process, and the amyl chloride is recycled to the digestors. Finally, the mixture of amyl alcohols is charged to a batch still where the various grades and isomers are separated by fractionation through a bubble cap column.

Reference: Petroleum Refiner, Sept.'53,p.207.



Butadiene from Butane

HOUDRY PROCESS COMPANY

Application: An adiabatic fixed-bed catalytic process for dehydrogenation of n-butane to butadiene and/or butenes.

Charge: Fresh feed of butane, together with the butane-butene mixture recycled from the final butadiene purification section.

Product: A crude butadiene stream from which high purity butadiene can be extracted.

Description: The charge is pumped from an accumulator through a feed-quench oil heat exchanger and a heater, being heated to approximately 1150 F. before entering the reactor.

Effluent from the reactor is quenched by direct contact with circulating quench oil, and moves from the quench tower to a knockout drum and then to the first of four compressor stages. Overhead from the last knockout drum passes to a conventional absorber and then to a stripper for recovery of C_4 and heavier material. Bottoms from the knockout drum also move to the stripper. Effluent from the stripper goes to the butadiene recovery and purification plant, and butane-butene recycle stock is then fed to the charge accumulator in a continuous operation.

On-stream time of each catalytic reactor in the series may be from 7 to 15 minutes, but generally is in the 8-10 minute range. Each on-stream period is followed by vacuum purge to remove hydrocarbons, after which regeneration is carried out with air that is pre-heated by direct combustion of fuel in the air stream.

In a three-reactor series, one chamber receives hydrocarbon feed while the second receives regeneration air and the third undergoes valve changes and purging.

Catalyst: The catalyst employed is in the form of cylindrical pellets consisting of active alumina impregnated with 18-20 percent chromic oxide. It is necessary to prevent contamination of the catalyst with iron. Small amounts of iron oxide are catalytically active at process conditions, resulting in large amounts of coke and light gas, plus spalling and catalyst breakage.

Operating Conditions: Major process conditions in butadiene production are as follows:

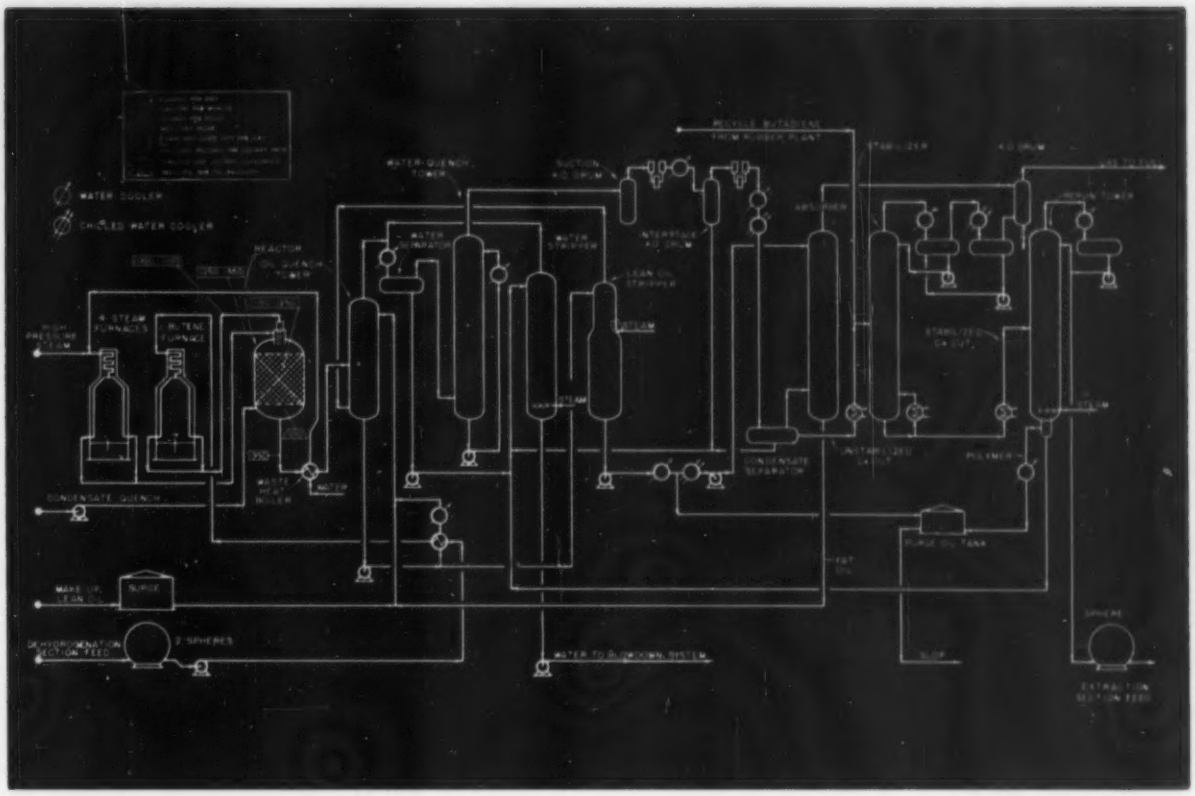
Average temperature	1125 F.
Pressure	5 in. Hg. Abs.
Space rate	1-1.5 vol. chg./vol. cat./hr.
On-stream period	8-10 min.

Yields: Plant experience shows that 11 to 11.5 weight percent butadiene per pass may be achieved, with ultimate total yield of about 52 percent butadiene.

COMPONENT	Fresh Feed Percent Weight	Recycle Percent Weight	Total Feed Percent Weight	Reactor Product Percent Weight	Ultimate Yield Percent Weight n-Butane Fresh Feed
Hydrogen	....	....	....	1.9	...
Methane	....	....	....	1.0	...
C_2	....	....	....	1.1	...
C_3	....	....	....	1.2	...
Isobutane	1.0	11.2	9.2	9.0	...
n-Butene	....	37.6	29.9	30.0	...
n-Butane	98.5	50.2	60.1	40.0	...
Butadiene	....	0.7	0.5	11.0	51.7
C_5+	0.5	0.3	0.3	0.5	...
Coke	....	....	....	2.6	...
Inerts	....	....	....	1.7	...
Total	100.0	100.0	100.0	100.0	...

Commercial Installations: Standard Oil of California at El Segundo, Calif.; units under construction for Texas Butadiene & Chemical Corp., Houston and Chemische Werke Huels, at Marl, Kreis Recklinghausen, West Germany.

Reference: PETROLEUM REFINER, Dec.'54,p173.



Butadiene from Butenes

ESSO RESEARCH AND ENGINEERING CO.

Application: A process for the catalytic dehydrogenation of normal butenes to butadiene-1,3.

Charge: A C_4 hydrocarbon stream containing about 80 weight percent n-butenes.

Product: A crude butadiene stream from which high purity butadiene can be extracted.

Description: The feed is preheated to about 1000 F. in the hydrocarbon superheater. The hot gases are then mixed with superheated steam and the mixture is passed through the fixed-bed catalyst. The low partial pressures necessary for the dehydrogenation of the butenes to butadiene by the catalyst are obtained by the use of this steam. Carbon deposited on the catalyst is removed by a "water gas reaction" with steam, partially during the dehydrogenation and partially during the regeneration cycle.

The hot gases leaving the reactor go through steam generators where they are cooled and where some of the steam for the process is generated. The hot reactor effluent is further cooled in an oil quench tower and a water quench tower. Water condensed from the effluent after compression is stripped of any volatile hydrocarbon in a water stripping tower and is then discharged to a blowdown system.

After compression and cooling, the effluent enters a condensate separator. The gases from the separator are fed to the absorber where the C_4 hydrocarbons are absorbed in a light naphtha which is then recycled to the oil quench tower. The condensate from the separator, containing the unstabilized C_4 cut, is fed to the stabilizer where the lighter components are removed overhead.

The bottoms stream from the stabilizer is fed to the rerun tower where the C_5 and heavier components are removed as bottoms. The overhead stream is the crude butadiene product.

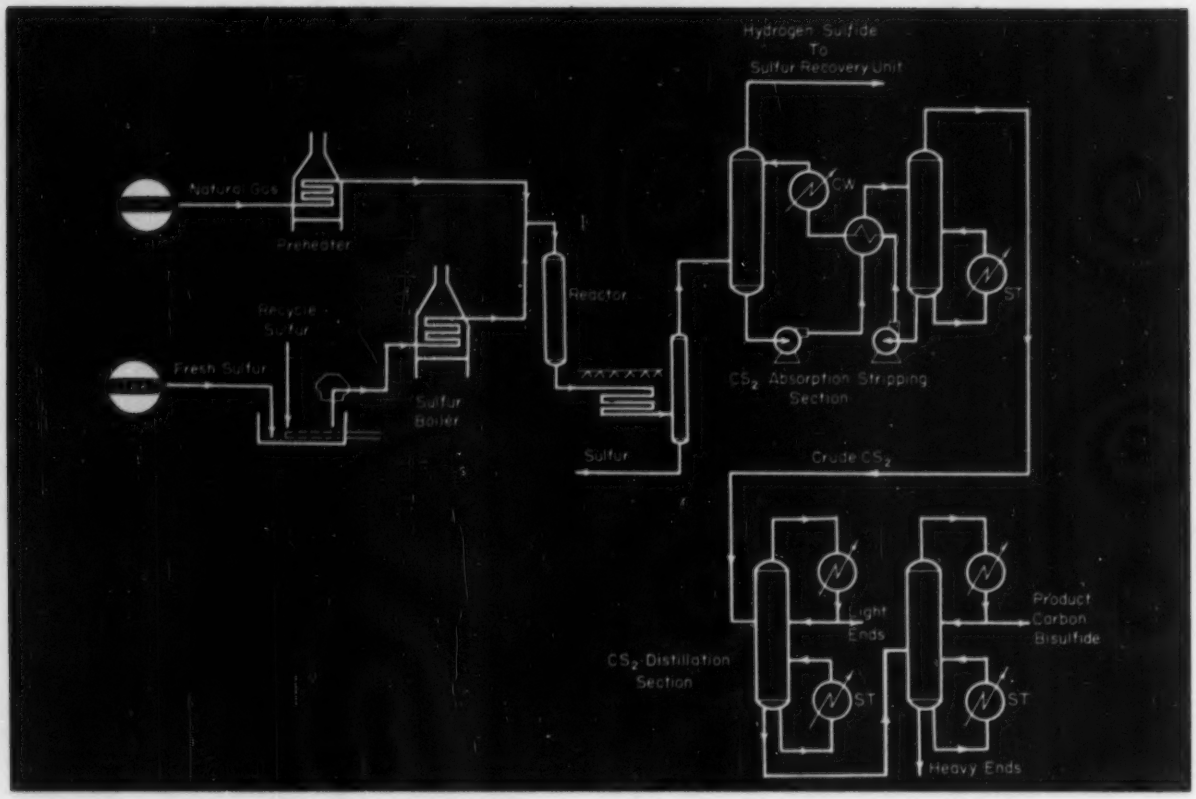
Operating Conditions: The principal operating conditions are:

Space velocity, V/H/V (Volume of n-butene as gas at standard conditions per hour per volume of catalyst)	125-225
Pressure Above Bed, psig	7-11
Pressure Below Bed, psig	2-4
Partial pressure, mm Hg. (at reactor inlet)	60-80
Steam/Butene, Gas Volume Ratio	14-18
Temperature, F.	1150-1250

Yields: Typical once-through yields* are as follows:

	Feed Weight Percent	Products Weight Percent
Normal Butenes	80.0	60.0
Butadiene	2.0	16.4
Other C_4's	18.0	16.0
Polymer	....	1.0
Fuel Gas and Coke	....	6.6

*Yields and operating conditions will depend upon the catalyst used.



Carbon Bisulfide

Application: A process for the manufacture of carbon bisulfide.

Charge: Natural gas, predominantly methane and containing a minimum of propanes-plus; sulfur, 99+ percent purity.

Product: Rayon-grade carbon bisulfide, 99+ percent purity.

Description: Fresh sulfur is melted, if necessary, and combined with recycle sulfur in an underground tank. The sulfur is maintained in the molten state at 250-270 F. by steam coils, and is transferred continuously to the boiler by means of a well-type pump. The boiler produces a superheated vapor at 1100-1200 F. and 20-30 psig, under which conditions most of the sulfur is in the diatomic form. The boiler is of stainless steel construction and presents maintenance difficulties due to the corrosiveness of sulfur and to the fouling tendencies of impurities in the sulfur. Pebble heaters have been proposed as a partial solution to this problem.

Methane (natural gas) is preheated separately to 1000-1200 F., depending on the heavy impurities and their tendency to decompose. The preheated sulfur and methane streams are then mixed and passed down through the reactor where carbon bisulfide is formed according to the formula:

$$CH_4 + 2\,S_2 = CS_2 + H_2S$$

The reactor is a vertical, stainless steel vessel filled with silica gel catalyst (a number of other materials may be used as catalyt) and operated adiabatically. Typical reaction conditions are: temperature, 1050-1150 F.; pressure 20-30 psig; vapor hourly space velocity, 400-600. Approximately stoichiometric proportions of sulfur and methane are used, and they are about 95 percent converted during passage through the reactor.

The reaction yields approach theory very closely. By-products include light mercaptans and heavy di- and poly-sulfides. The reactor effluent is cooled in a sprayed U-bend exchanger and passed to a tank from which condensed sulfur is withdrawn at 250 F. This sulfur could be recycled, but is small in quantity and in addition contains accumulated tars.

Sulfur is de-entrained from the exit gases, and they are then fed to an absorption column in which carbon bisulfide is removed by a selective, mineral oil-type solvent. The rich oil is pumped to a stripper where the carbon bisulfide is removed and sent to the distillation section. The off gas from the absorber contains 90-95 percent hydrogen sulfide and passes to a sulfur recovery unit. Details of this unit are given elsewhere in this handbook.

The stripped carbon bisulfide is purified in two successive distillations, with the final product being taken overhead from the second column. The distillation columns are of steel construction and utilize refrigerated overhead condensers.

The carbon bisulfide product is stored and shipped in steel containers. A blanket of water is used to minimize fire hazards. Further purification of the product is required before it can meet USP requirements.

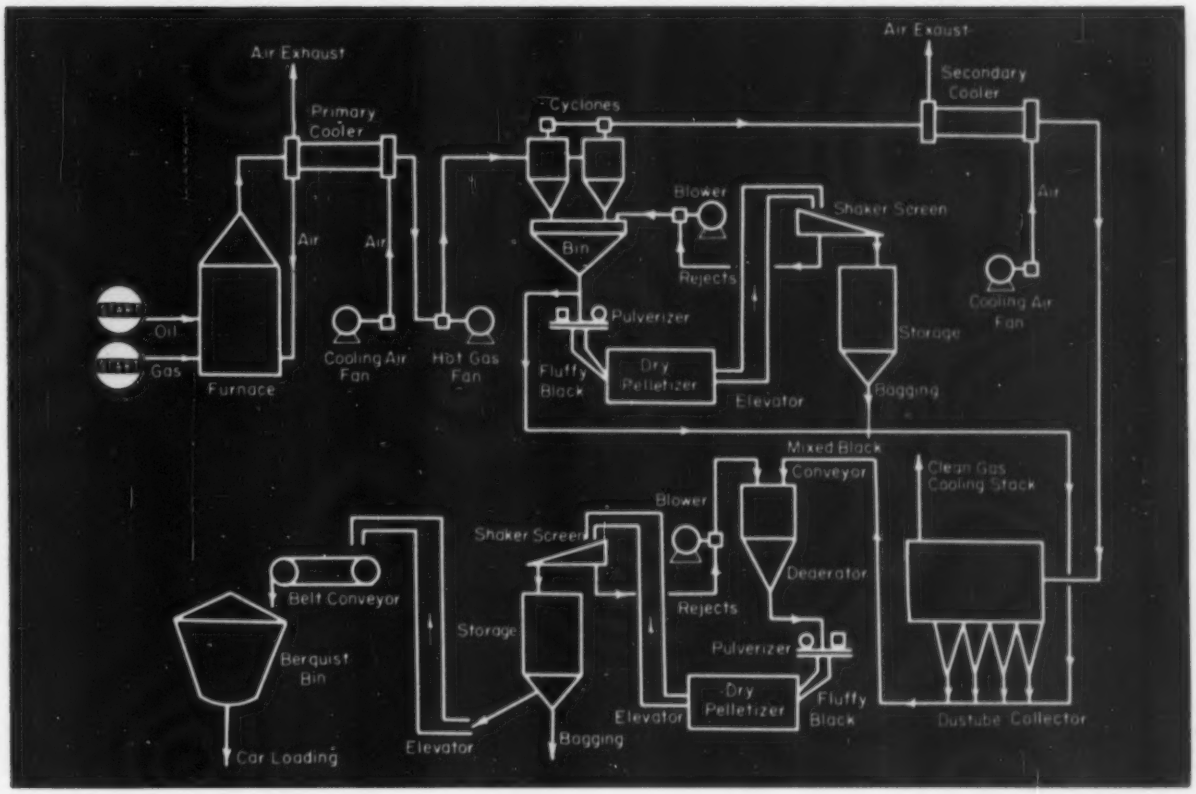
Operating Conditions: Typical conditions for the catalytic reaction between methane and sulfur are given in the above text.

Yields: Typical over-all process yields:

Carbon bisulfide from methane — 90-95 percent
Carbon bisulfide from sulfur — 85-90 percent

Commercial Installations: This process or a variation is used by Barium Reduction Corp., South Charleston, W. Va.; Food Machinery and Chemical Corp. (Westvaco Chlor-Alkali Division), South Charleston, W. Va.; Stauffer Chemiacl Co., Mobile, Alabama (under construction).

Reference: For a discussion of the reaction conditions, see the paper by H. Folkins, E. Miller, and H. Hennig, *Ind. Eng. Chem.*, 42, 2202 (1950).



Carbon Black (Lynn Process)

LYNN CARBON BLACK CO., INC.

Application: A process for the manufacture of furnace type carbon black.

Charge: Natural gas of a combination of natural gas and petroleum oil.

Description: The furnace types of carbon blacks are normally made by the high temperature cracking of natural gas and/or petroleum oil and are known as gas blacks or oil blacks, depending upon the primary feed stock. Carbon blacks are further separated into color or rubber blacks with varying properties which must be closely controlled to the specifications and grades required for their intended commercial use.

The simplified flowsheet is typical for a plant producing a gas black or a combination of gas and oil blacks with an approximate 50 percent oil charge. In the manufacture of gas blacks natural gas is introduced into the interior of a multi-port burner at a very low pressure, preheated air is simultaneously introduced around the lazy flame of the gas burner, but at a low point in the interior of the furnace. Temperatures in this zone range from 2200-2400 F. The combustion process temperatures are in the main controlled by the air-gas ratio which may vary from 4:1 to 8:1 depending on the type and quality of carbon black to be made.

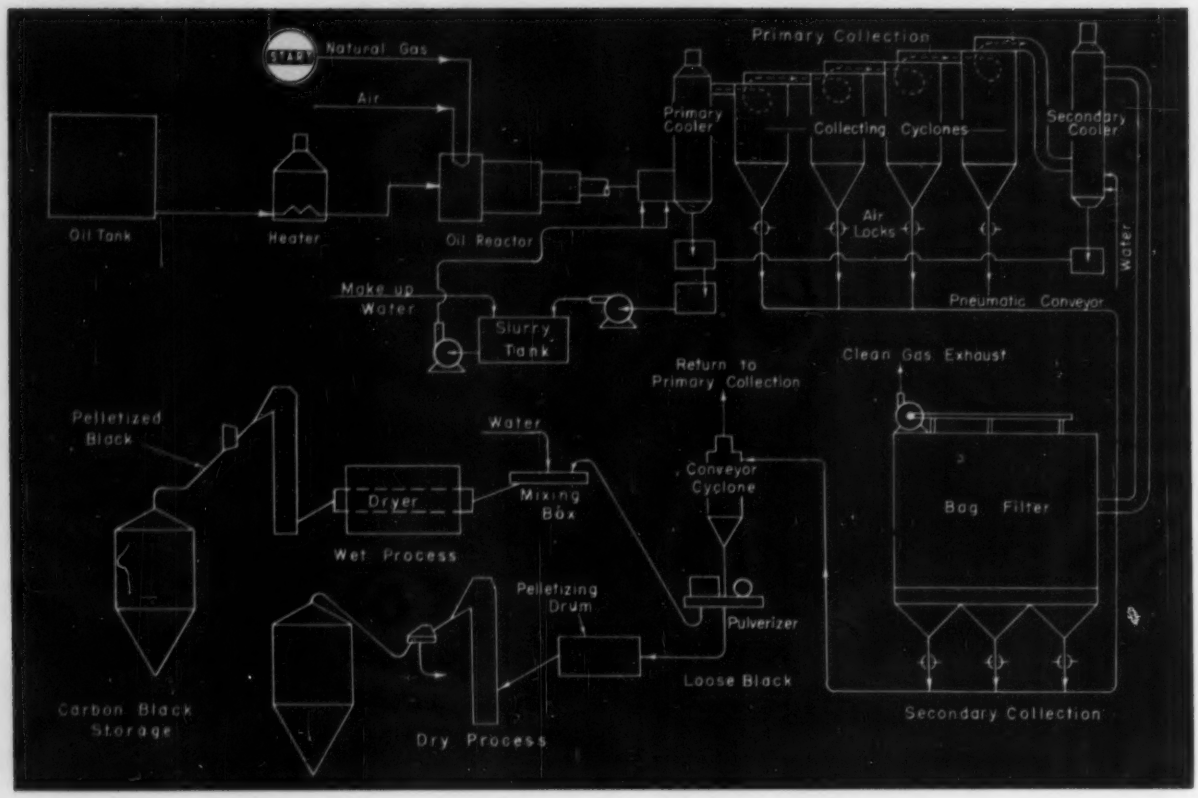
Above the gas burners at higher temperatures, dissociation occurs. It is within this zone that oil, when used, is introduced by means of vertically located air-cooled oil burners with mechanical atomization and varying air ratios. The furnace contains an adjustable hood, which may be raised or lowered for optimum operating conditions and products. Within this hood, a highly turbulent region exists and temperatures may vary from 2600-3000 F. and the feed-stock is cracked to its components of carbon and hydrogen. The conditions that obtain in this zone may be described as a heterogeneous gas phase catalytic reaction, the hood acting as the catalyst. Products of combustion and carbon black produced, then leave the furnace and enter the primary cooler.

In the primary cooler the carbon black gas mixture is cooled to about 1000 F. with a counter-current flow of air. An additional reversible reaction occurs during this stage which adds to the yield of carbon black and agglomeration takes place. From the primary cooler the products enter cyclone collectors where between 60 to 80 percent of the black is collected, atmospherically cooled and stored for bagging or pelletizing, or sent on for mixing with final products.

From the cyclones the balance of the carbon black gas mixture enters the secondary cooler where it is cooled to about 275 F. and then enters a Dustube collector where the balance of the black is collected. Carbon black from the secondary collector may be mixed with the primary product or sent on to the deaerator for compaction as a loose or fluffy black. Both the primary and secondary recovered blacks must be pulverized and are therefore sent through a high speed hammermill before either bagging as a loose black or to be pelletized. Pelletizing is accomplished by means of a dry process wherein the carbon black is fed into a slowly rotating drum which forms small pellets. The pellets are then elevated to a shaker screen where they are separated and screened to the required size, rejects are returned to the hammermill. Pelletizing increases the bulk density which, in the typical rubber blacks vary from 21-24 pounds per cubic foot, it also results in a relatively clean and free flowing product, much preferred by the user.

Yields: The yields are dependent upon the carbon content of the feed stock. Recoveries from an average natural gas are about 12-14 pounds per 1000 cubic feet for the Semi-Reinforcing Furnace type of blacks.

References: *Chemical and Engineering News*, Vol.32,No.33,Aug. 16,'54,p3294; *Chemical Week*, Aug.14,'54,p40; *Chemical Engineering*, July'53,p120; *The Oil and Gas Journal*, May9,'55,p120.



Carbon Black (Oil Black)

Application: A process for manufacturing highly-reinforcing furnace blacks from heavy residual oils.

Charge: Heavy residual oil, natural gas, air.

Products: HAF and SAF carbon blacks, pelletized, bulk density 23 pounds per cubic foot minimum.

Description: Oil is preheated in a direct-fired or molten-salt type heater and introduced into a reactor in which gas and air are burned to provide the heat necessary to crack the oil. The furnace used is the Phillips type reactor (Krezci, J. C., to Phillips Petroleum Company, U. S. 2,564,700, August 21, 1951) under a licensing agreement. Air for the reactor is furnished by centrifugal blowers. The temperature in the oil reactor is maintained at about 2500 F by controlling the air pressure at about 4 psig. The oil is cracked to carbon and hydrogen with side reactions producing carbon dioxide, carbon monoxide, and water. Trace amounts of acetylene and methane are also produced.

In the quench section of the reactor, direct water sprays cool the carbon black-gas mixture to about 1200 F. The mixture is air-cooled in a long duct, partially finned to take advantage of some air cooling, to about 700 F. in a long ceramic tube, then enters a vertical cooling tower, sized for a velocity of about 25 feet per second, in which water sprays reduce the temperature to about 550 F.

The cooled reaction mixture passes into a series of four cyclones which remove about 70 percent of the black, then into a secondary cooler in which more water sprays cool to under 300 F. Final cleaning of the gas occurs in a bag filter in which Orlon bags remove essentially 100 percent of the black. Alternatively, a wet scrub may be used for final recovery, with the resultant slurry used for quench water in the furnaces.

Carbon black is continually discharged from the collection equipment by rotary valves and picked up by a pneumatic conveyor. The black is collected in a smaller diameter collecting cyclone and discharged through a high speed hammer mill to break up and disperse the very small quantities of hard agglomerates that may be present.

Carbon black is pneumatically conveyed to the pelletizing systems, after passing through a high-speed hammer mill to eliminate hard aggregates. Either wet or dry pelletizing is used, depending on the bulk density required and the method of shipment preferred.

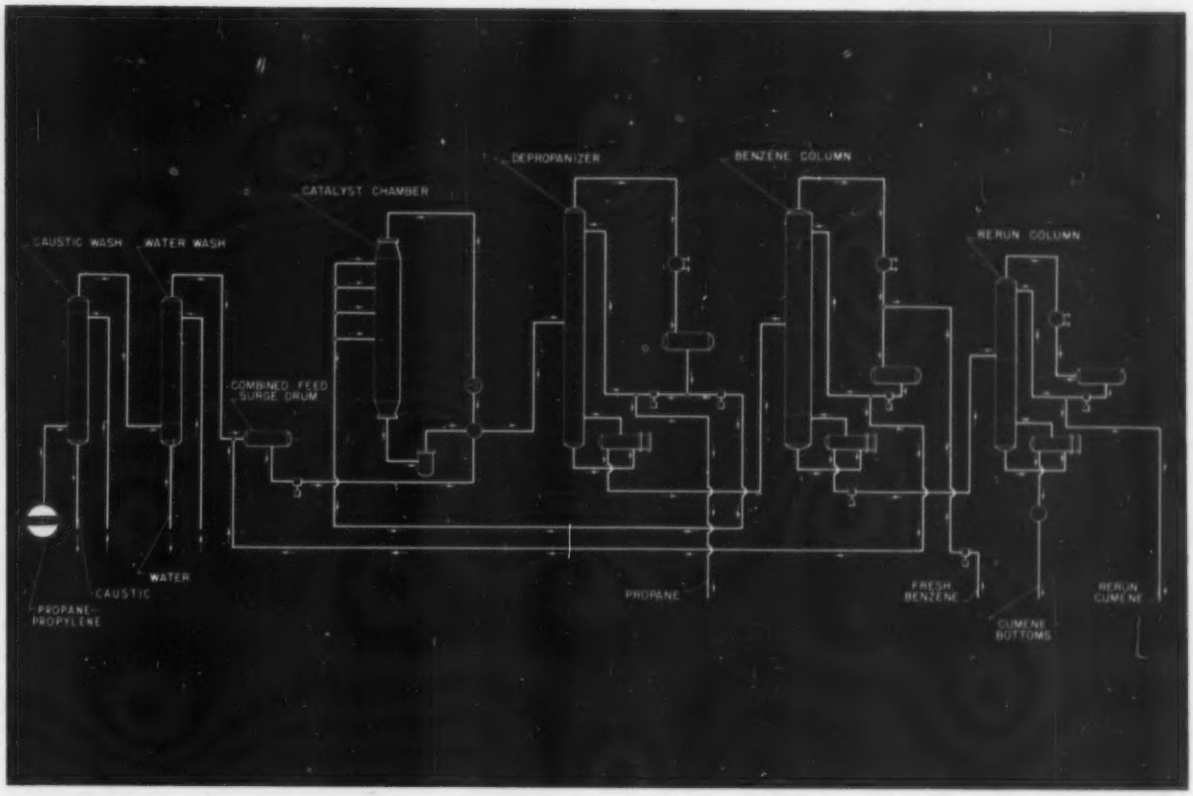
Pelletized black is shipped in bulk hopper cars or in 50-pound three-ply kraft paper bags.

Operating Conditions: The critical operating conditions are those in the reactor design. Reactor design and control determine yields and quality.

Yields: The process yields up to 60 percent of the actual carbon content of the oil feed as finished black.

Commercial Installations: This process or variations is in use by Continental Carbon Company at Ponca City, Okla., and Westlake, La.; and by Cabot Carbon of Canada, Ltd., at Sarnia, Ont.

Reference: Petroleum Refiner, Dec. '54, pp. 179-181.



Cumene

UNIVERSAL OIL PRODUCTS COMPANY

Application: A process for alkylating propylene and benzene.

Charge: Propane-propylene and benzene.

Product: Isopropyl benzene (cumene), heavy aromatics, and propane LPG.

Description: The propane-propylene charge to the Cumene unit should be treated for the removal of hydrogen sulfide and basic nitrogen compounds before being charged to the catalyst section. The hydrogen sulfide removal is generally accomplished by treatment with caustic, although any other suitable method may be employed.

The removal of basic nitrogen compounds from the poly plant feed can be accomplished by the contact of the hydrocarbon stream with fresh clean water in a countercurrent wash tower. In those cases where fresh clean wash water of the desired pH is not available in quantities sufficient to provide adequate water washing of the feed, economy in the use of water can be obtained by recirculating water and controlling pH of wash water by the injection of acid. With such a system water makeup is reduced to that required to keep the wash water reasonably low in inorganic salt content.

Following the water washing operation, the propane-propylene charge flows to a combined feed surge drum where it combines with benzene.

The combined propane-propylene and benzene is then charged through suitable heat exchange to the catalyst section. The alkylation reaction is carried out using solid phosphoric acid catalyst under controlled conditions of temperature and pressure.

The effluent from the reaction zone flows to the fractionation section of the Cumene unit, which consists of a depropanizer, benzene column, and rerun column. These towers and their auxiliaries may be conventional in design, the net products being propane LPG, benzene drag stream, rerun cumene and cumene bottoms.

From the depropanizer a portion of the spent propane-propylene is made available as quench material to be used for the purpose of controlling the temperatures in the catalyst chambers. The net spent propane-propylene may be pumped as a liquid to LPG drying and storage or used directly as fuel gas.

The depropanized product is separated into recycle and crude cumene by the benzene column. A small part of the recycle is periodically withdrawn as a drag stream to remove contaminants.

The benzene column controls the initial boiling point of the cumene product. The benzene overhead stream from this column is recycled along with fresh benzene to the combined feed drum, and the bottoms are charged to the rerun column, where cumene is separated from higher boiling aromatics. The process equipment using the same catalyst is also suitable for making diisopropyl benzene and butyl benzene.

Yields:

Fresh Feed:	Vol. Percent	Products:	Vol. Percent
Propane-propylene	69.0	Propane LPG	43.5
Benzene	31.0	Rerun Cumene	53.5
		Bottoms	3.0
	100.0		100.0

Commercial Installations: Eight units were operating during the World War II period. Since that time three new units have been placed in operation.

Reference: PETROLEUM REFINER, Dec.'54,p186.

Chlorinated Methanes

Commercial Installations: This process or a variation is used at the following plants: Allied Chemical & dye Corporation, Solvay Process Division, Moundsville, W. Va.; Diamond Alkali Company, Belle W. Va.; Dow Chemical Company, Pittsburg, Calif., and Freeport, Texas.

References: PETROLEUM REFINER Dec. '54 pp 136; Hirschkind, W., *Ind. Eng. Chem.*, Vol. 41,2749,1949.

Application: This is a process for the manufacture of chlorinated methanes.

Charge: Methane, 99 percent purity, and chlorine, 99 percent purity are the charge.

Products: Methyl chloride (CH_3Cl), 99 percent purity; Methylene chloride (CH_2Cl_2), 88-92 percent purity; carbon tetrachloride (CCl_4), 99.5 percent purity; chloroform ($CHCl_3$), 99 percent purity are the products.

Description: The methane used in this process must be carefully refined to a purity of 99 percent or better. This is accomplished by selective absorption or by other conventional techniques. Impurities in the charge gas react selectively to reduce the yield of chloromethanes.

Chlorination may be effected by either photochemical or thermal means. In the representative case described below, the thermal technique is used for the primary chlorination and the photochemical technique is then used for the succeeding secondary chlorinations. It should be pointed out that slight variations in reactant ratio and operating conditions can alter the product distribution considerably. The chlorination reactions are strongly exorthermic, and close control must be exercised to prevent degradation to products of carbon and hydrogen chloride.

Chlorine and methane (including recycle) are charged separately to the primary reactor in a molar ratio of 0.6:1.0. A temperature of 650-700 F. is maintained within the reactor, the reactants being preheated by the products. Chlorine conversion is essentially 100 percent. Methane conversion is about 65 percent. High velocities are maintained through narrow channels in order to prevent ignition. The operating pressure is slightly above atmospheric. The effluent gases include unreacted methane, traces of chlorine, hydrogen, chloride, heavy chlorinated compounds, and chloromethanes in the following approximate ratio:

Methyl chloride	6.0
Methylene chloride	3.0
Chloroform	1.0
Carbon tetrachloride	0.25

The products are cooled in a tubular exchanger and are sent to the main absorber where chlorinated compounds are removed from methane and hydrogen chloride. The latter two materials comprise 75-80 percent of the reactor effluent. The solvent for the absorber is a refrigerated mixture of chloroform and carbon tetrachloride. the lean gas from the absorber, containing less than 3 percent chlorinated hydrocarbons, passes to a water-cooled karbate tower where it is scrubbed with dilute (less than 15 percent) hydrochloric acid. Thirty-two weight-percent acid is withdrawn from the bottom of the tower. The off gas is then scrubbed with caustic and dried with 98 percent sulfuric acid in separate towers. The resulting dry methane is recycled to the primary reactor by means of a blower.

The bottoms stream from the main absorber is preheated and sent to the main stripper where residual chlorine and hydrogen chloride, plus significent amounts of lower chlorinated materials are removed overhead. The off gas passes to a rubber- and brick-lined tower where hydrogen chloride is removed by scrubbing with 130 F. water. The tower is operated at elevated temperatures since the chlorinated materials have a dew point in the vicinity of 100 F. The lean gas contains 0.3-0.5 percent hydrogen chloride and is saturated with water. Neutralization and drying are accomplished by successive scrubbing with dilute caustic and 98 percent sulfuric acid.

The dry gas is compressed to about 110 psig and fed to the methyl chloride column. The overhead product contains 99 percent methyl chloride, meting technical grade specifications. It is flammable and toxic, and requires special handling precautions.

A portion of the methylene chloride present in the methyl chloride tower bottoms is distilled overhead in a second fractionator. The methylene chloride product has a purity of 88-92 percent. The bottoms from this second fractionator are combined with the bottoms from the main stripper and charged to secondary reactor "A."

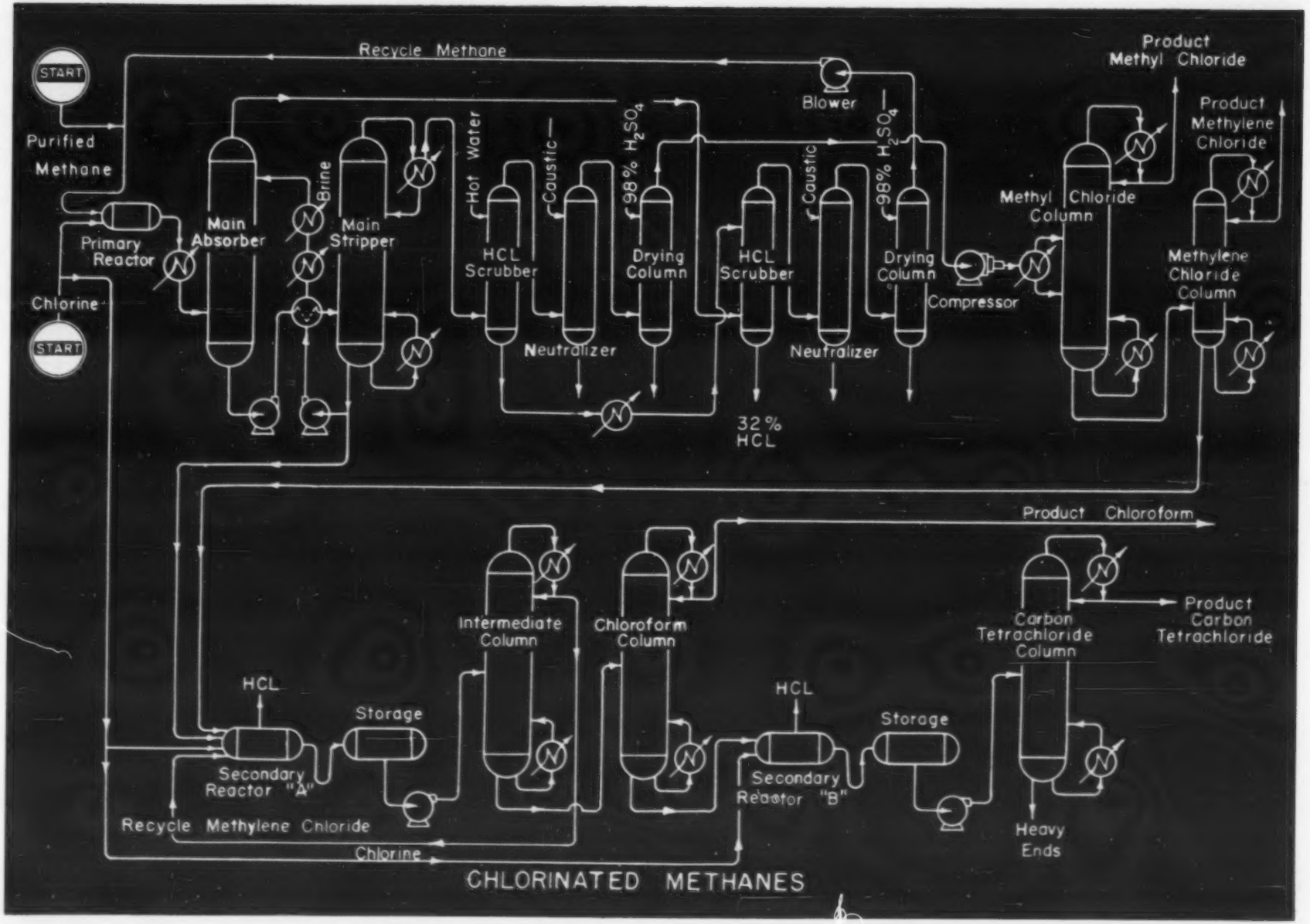
The secondary chlorinations are carried out in the liquid phase, using photochemical activation. Special reactors expose a maximum of liquid at close range to a mercury arc lamp. Fresh chlorine is introduced to convert methylene chloride to chloroform. The reactor operates at essentially ambient temperature, with the exothermic heat of reaction being removed by cooling coils and a reflux condenser. Hydrogen chloride escapes and is collected in scrubbing towers (not shown on the flow diagram).

The overflow from the reactor goes to a storage tank and thence to the intermediate column, where unreacted methylene chloride is removed overhead and recycled to the reactor. U. S. P. Chloroform (99.0-99.5 weight percent) is taken overhead in the following fractionator. The bottoms stream from this second tower contains chloroform and lesser amounts of carbon tetrachloride and high boilers. It is mixed with fresh chlorine to form the charge for secondary reactor "B."

In this second photomechanical reactor chloroform is converted to carbon tetrachloride. The effluent passes to a fractionator where 99.5 percent carbon tetrachloride is removed overhead.

Operating Conditions: Chlorination conditions vary with the product distribution desired, which in turn varies with market conditions. A representative set of operating conditions for the primary chlorination is included in the above text.

Yields: Over-all process yield, methane to chlorinated methanes is 85-90 percent.


START
Purified Methane
Chlorine
START
Recycle Methane
Blower
Primary Reactor
Main Absorber
Brine
Main Stripper
Hot Water
HCL Scrubber
Caustic
98% H_2SO_4
Neutralizer
Drying Column
HCL Scrubber
Caustic
98% H_2SO_4
Neutralizer
Drying Column
Compressor
32% HCL
Product Methyl Chloride
Methyl Chloride Column
Product Methylene Chloride
Methylene Chloride Column
Product Chloroform
Intermediate Column
Chloroform Column
Carbon Tetrachloride Column
Product Carbon Tetrachloride
HCL
Storage
Secondary Reactor "A"
Recycle Methylene Chloride
Chlorine
HCL
Storage
Secondary Reactor "B"
Heavy Ends
CHLORINATED METHANES

Direct Oxidation of Propane—Butane CELANESE CORPORATION OF AMERICA

Chemcel Plant

Application: This process is for the production of a number of organic aliphatic oxygenated chemicals and some derivatives from these chemicals.

Charge: Propane and butanes are consumed principally, although some other hydrocarbons would be permissible.

Products: The products are acetic acid, acetaldehyde, formaldehyde in various forms and mixtures with other materials, acetone, alcohols, esters, several glycols and mixtures of alcohols or ketones designated as solvents.

Description: The Chemcel operation, which is continuous, starts with separate compression of air and the specified hydrocarbon gases, an excess being used of hydrocarbons to aid in controlling subsequent reactions. The separate gas streams are united and fed to the oxidation furnace where partial oxidation of the hydrocarbons in the gas stream occurs. This primary oxidation is effected in a group of identical furnaces, operated in parallel, which provide for preheating the mixture as well as suitable conditions for the reaction. After brief residence in the furnaces, the gas stream, which has become enriched with primary products formed in the hot reaction chambers, is quenched and absorbed in towers containing water. Vented from these absorbers are unreacted hydrocarbons, which are recycled to the compressors for re-use, and nitrogen under pressure which can be used for driving turbines.

At this stage, a separation of the crude water-chemical mixture is effected. Dilute formaldehyde is isolated first and is subsequently concentrated to the usual water solution known as formalin. Some of the formalin is processed, essentially by dehydration, to yield paraformaldehyde and trioxane.

The portion of the water-chemical mixture remaining after formaldehyde removal is subjected to appropriate procedures for separating and purifying the various chemical components consisting largely of alcohols, aldehydes, ketones and oxides. Chemicals emerging from this step are then ready either for marketing or for additional chemical processing to produce up-graded materials.

These advanced processing steps include secondary oxidation, hydrogenation and esterification. In these steps, techniques are employed involving simple and azeotropic distillations, fractionation, solvent-type extraction, evaporation, absorption and other unit processes.

Operating Conditions: These do not for the most part involve extremes, but rather entail careful control of pressures, temperatures, rate of feed, catalyst and air-hydrocarbon ratios.

Yields: The operations are inherently flexible in that process equilibria can be controlled to the extent of allowing significant changes to be made in the outputs of the various chemicals.

Commercial Installation: This plant has been in production since 1945 and is located near Bishop, Texas.

Pampa Plant

Application: This process is for the manufacture of various organic aliphatic oxygenated chemicals.

Charge: The charge is primarily normal butane, although some higher hydrocarbons and propane can be tolerated.

Products: The principal products are acetic acid and acetic anhydride. Other products are vinyl acetate, acetaldehyde, acetone, methanol, and propionic and butyric acids.

Description: Compressed air and butane are fed to vessels where the oxidation of the hydrocarbons takes place. The reaction-product mixture is run through coolers, including a battery of air-type heat exchangers, and then to separators where nitrogen and other gases are released. As this nitrogen is under considerable pressure, it is used to drive turbines in the process. The other components of these gases are the unreacted hydrocarbon material which is recycled to the reactors.

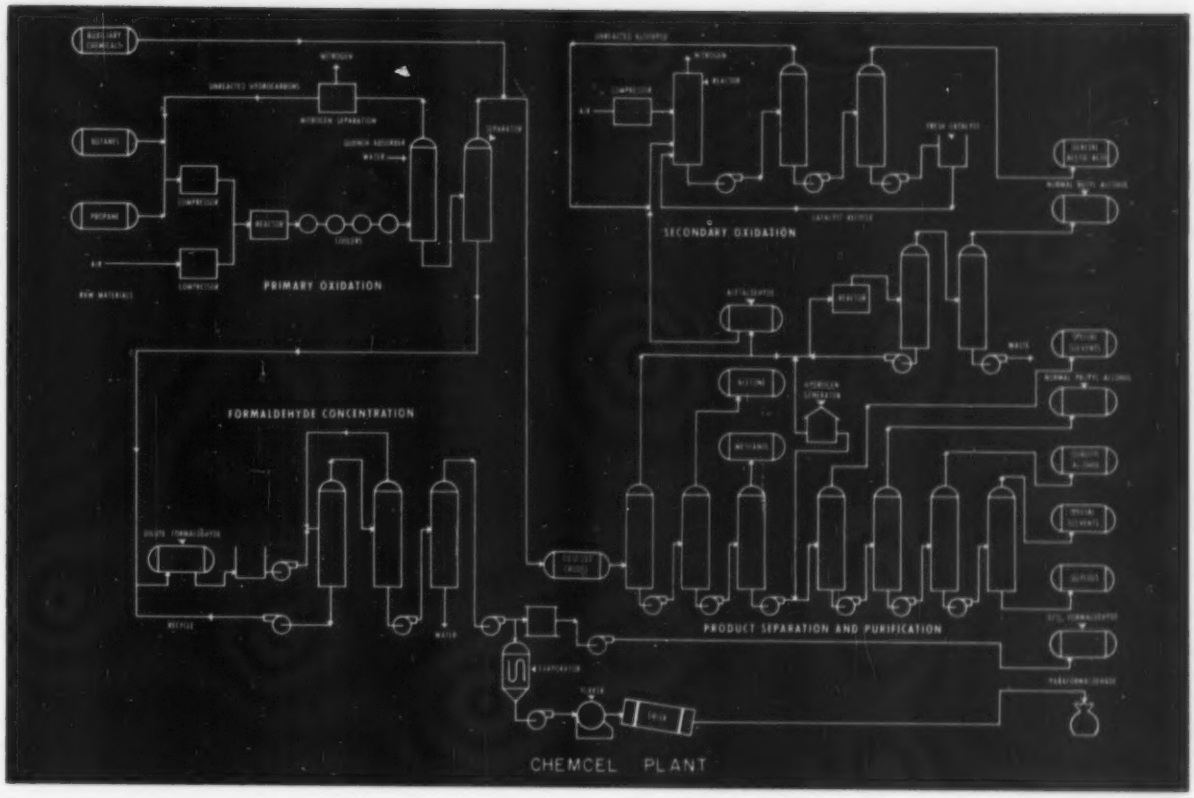
The liquid extract, or oxidized crude, is processed further to effect a separation of the relatively low boiling components. These low boiling components are the major product, acetic acid, and higher boiling materials. The acetic acid, after being separated from the oxidized crude mixture is fed to the anhydride unit, which has the capacity for high-efficiency conversion of all acetic acid produced (design capacity 1,800,000 pounds per week) to acetic anhydride. Also at this end of the plant is the new vinyl acetate unit, which has design capacity for production of more than 30 million pounds a year.

In addition to the main process equipment, a "utility" or "special products" unit is provided. This unit is comprised mainly of reaction and storage tanks and two large fractionating towers together with necessary auxiliary facilities. It is designed for either batch or continuous production and can operate both on co-products from the principal process streams and on large volume specialty products.

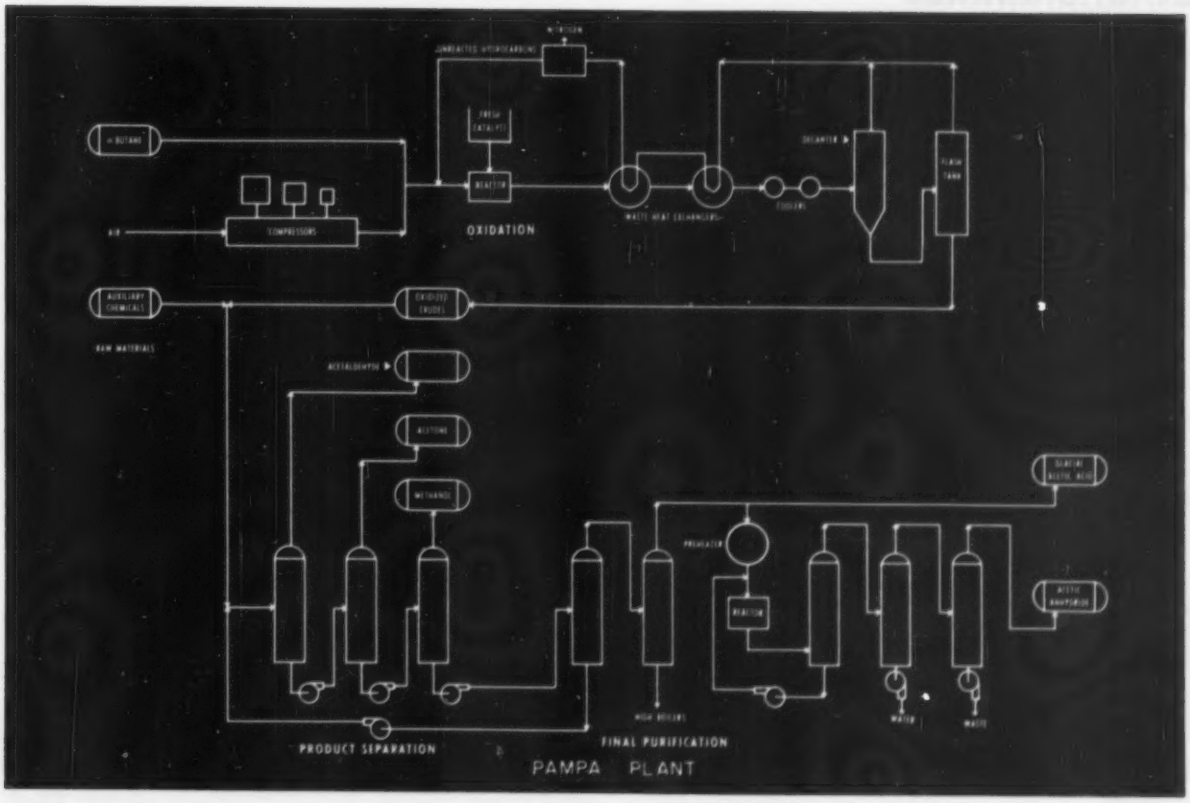
In addition to adopting a modified version of the basic process used in the Chemcel plant, a number of changes were made in equipment design. Perforated plate or sieve-type process columns are standard for the plant. Sieve trays were used because they were less expensive initially and are very satisfactory as to operating flexibility, ease of control and quality of product.

Another difference in design of the two plants is the use of air-cooled heat exchangers which are used to handle approximately 80 percent of the total cooling load at Pampa. This reduces the plant's dependence upon the vagaries of the weather in providing water for cooling purposes as the plant is situated in a region of scanty rainfall.

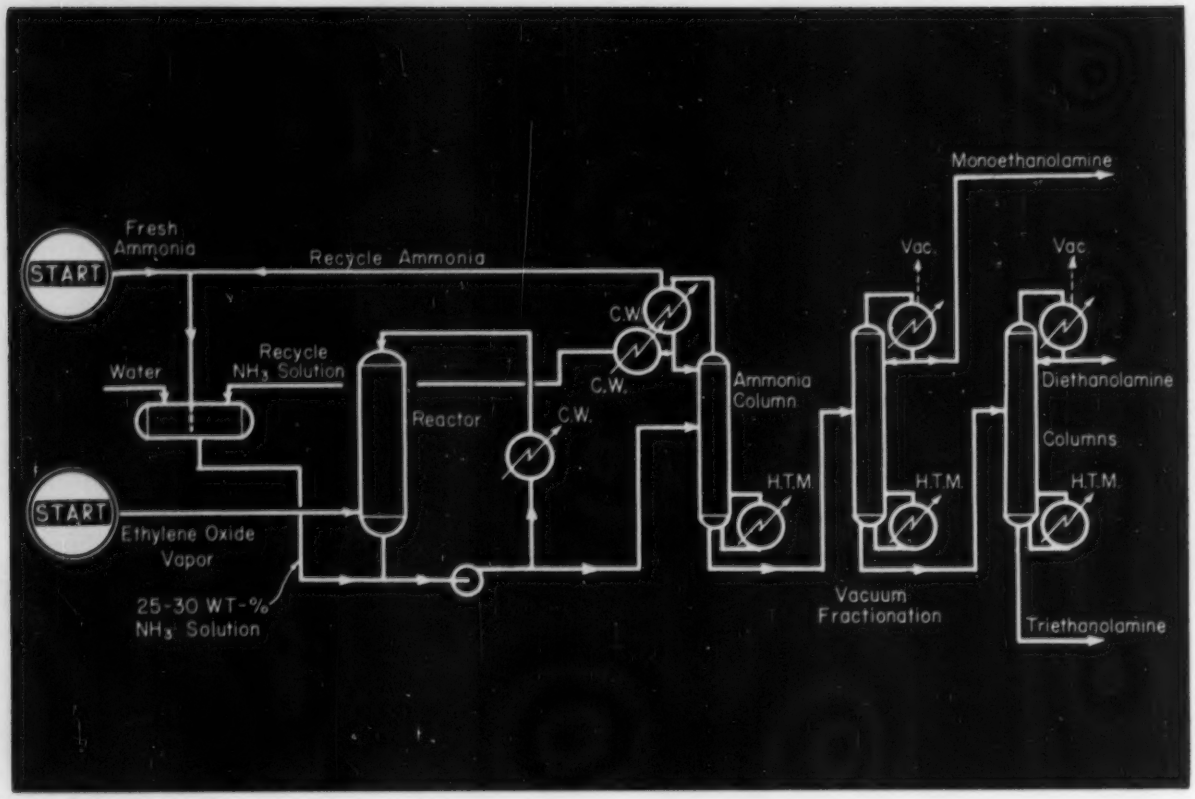
Commercial Installation: This plant has been operating at a location about 6 miles from Pampa, Texas, since late in 1952.



CHEMCEL PLANT



PAMPA PLANT



Ethanolamines

Application: A process for the manufacture of ethanolamines.

Charge: Ethylene Oxide, 99.5 percent purity, anhydrous ammonia.

Products: Mono-, Di-, and Triethanolamine of 98, 95, and 80 wt.-percent purity.

Description: Monoethanolamine (MEA), diethanolamine (DEA), and triethanolamine (TEA) are produced commercially by the reaction between ethylene oxide and ammonia. Through control of reaction conditions the distribution of the amines in the product may be varied in accordance with market requirements. Commercial plants for the production of ethanolamines are quite flexible with regard to production demands.

Ethylene oxide from an adjacent production unit is charged separately to the base of the reaction tower. Here it is contacted by a 25-30 wt-percent aqueous ammonia solution in the presence of a large amount of reaction products. The reactions are relatively slow and quite exothermic; hence the reaction mixture is circulated through an external cooler at a high recycle:fresh feed ratio. The makeup ammonia solution is added to the suction of the circulating pump.

The reactor is a vertical steel vessel about half-filled with liquid. Internal packing and auxiliary cooling coils may be used. The reactor contents are maintained at 85-100 F. and about 10-20 psig. Since ethylene oxide reacts faster with MEA and DEA than with ammonia, careful control of the ethylene oxide:ammonia ratio is exercised. The effect of reactant ratio is shown in the following tabulation:

Weight Ratios of Ethanolamines in Reactor Product

	Moles ethylene oxide/mole ammonia		
	0.1	0.5	1.0
MEA	75	25	12
DEA	21	38	23
TEA	4	37	65

In practice, the ratio will range from 0.1 to 2.0 moles ethylene oxide per mole of contained ammonia, with usual operations employing ratios of 0.3-0.6. Conversion of ethylene oxide is essentially complete, with yields of the desired amines on the order of 95 percent. Some heavy ends are formed, these being principally higher ethylene oxide ethers of TEA.

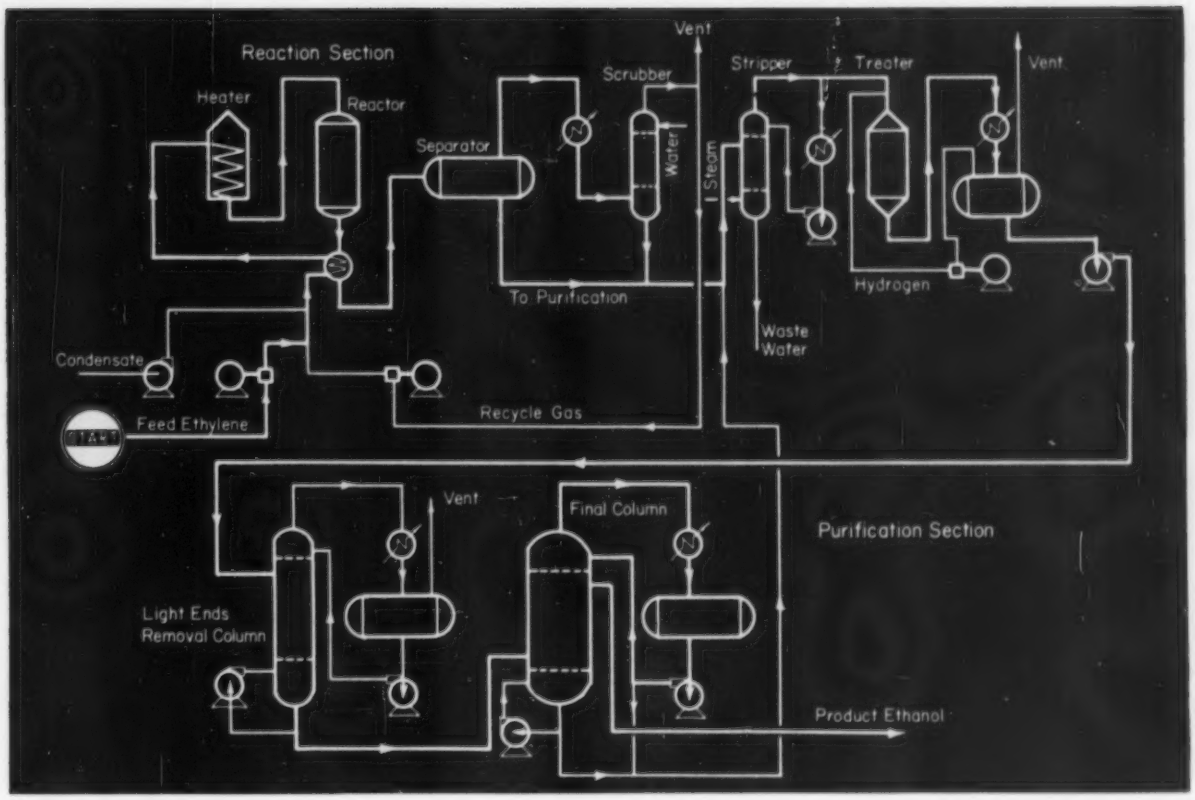
The net reaction product is withdrawn from the circulating pump and fed to an atmospheric distillation column where ammonia and water are removed overhead. These products are returned to the ammonia solution tank where they are blended with fresh ammonia. When operations are such that high yields of TEA are produced, the bottoms from the ammonia column may be marketed directly as technical triethanolamine. Otherwise, the bottoms stream is fed to the vacuum distillation columns for further separation.

The vacuum columns are designed for a high degree of flexibility in operation. They are of steel construction, contain 20-30 trays, and are reboiled by Dowtherm or equivalent heat transfer medium. The overhead from the first column is 98 percent monoethanolamine product. The overhead from the second column is 95 percent diethanolamine product, with the impurities about equally divided between MEA and TEA. The bottoms from the second column is commercial triethanolamine, which contains some 10-15 percent DEA, 1-3 percent heavy ends, and the remainder TEA. In cases where vacuum fractionation is not necessary, as much as 2.5 percent MEA may be present.

Operating Conditions: Reaction conditions vary with the distribution of the three amines desired; a discussion of this point is included in the above text.

Yields: Over-all process yields of the three amines are on the order of 95 percent, based on both ethylene oxide and ammonia.

Commercial Installations: This process or a variation is used by Allied Chemical and Dye Corporation, Orange, Texas; Carbide and Carbon Chemicals Company, South Charleston, W. Va.; Dow Chemical Company, Midland, Mich.; Jefferson Chemical Company, Port Neches, Texas; Olin Mathieson Chemical Corporation, Brandenburg, Ky.



Ethanol

SHELL DEVELOPMENT COMPANY

Application: A process for the manufacture of ethanol.

Charge: Ethylene gas (97 percent purity) and water vapor.

Products: Ethanol 95 volume percent purity.

Description: The reaction section shown is only one of several parallel units making up the plant. The feed ethylene is compressed to approximately 1000 psi in the feed compressor. This stream is combined with the recycle stream from the recycle gas compressor and joined by a controlled stream of water in the ratio of 0.6 moles of water per mole of ethylene. This stream is pre-heated by exchange with the reactor product and totally vaporized in a gas fired furnace and heated to a final temperature of 570 F. before going into the top of the reactor.

The feed passes downward through the catalyst bed (phosphoric acid supported on diatomaceous earth) and a fraction of the ethylene and water is converted to ethyl alcohol on each pass through the reactor. Since the reaction is exothermic, products leave the reactor at slightly higher than the feed temperature.

The reactor product is exchanged with feed, neutralized with caustic soda and separated into liquid and vapor in a high pressure separator. The liquid product goes to the purification section. The vapor is cooled in the recycle gas cooler and scrubbed to remove ethanol. This ethanol-water mixture is sent to the purification section and the gas from the scrubber is recycled. Some of the recycle gas is vented to the ethylene plant to limit concentration of ethane and methane in the reactor feed.

The crude product from the several parallel reactor streams is combined and separated in a low pressure separator. This crude stream is steam stripped, the bottoms going to waste, and the overhead going to the treater. In the treater, the crude stream is combined with a recycle hydrogen stream and, over a nickel catalyst, the trace amounts of aldehydes are converted to the corresponding alcohols.

In the final purification section the light-ends column removes light by-products, principally diethyl ether, and the final column purifies the ethanol.

Reactions: In the Shell Hydration Process, ethylene and water combine chemically by the reaction:

$$C_2H_4 + H_2O + \xrightarrow{H_3PO_4} C_2H_5OH + 19{,}000 \text{ BTU/Lb. Mole}$$

The primary side reaction forms diethyl ether by dehydration of ethanol:

$$2\,C_2H_5OH \xrightarrow{\text{Catalyst}} (C_2H_5)_2O + H_2O$$

Acetylene, present as an impurity in the feed ethylene, forms acetaldehyde:

$$C_2H_2 + H_2O \xrightarrow{\text{Catalyst}} CH_3CHO$$

In addition, a small amount of ethylene polymerizes to form less than one percent of a wide range of olefinic polymers.

The hydrogenation reaction converts the aldehydes to alcohols over a nickel catalyst. In this way acetaldehyde is converted to ethyl alcohol:

$$CH_3CHO + H_2 \xrightarrow{\text{Catalyst}} C_2H_5OH$$

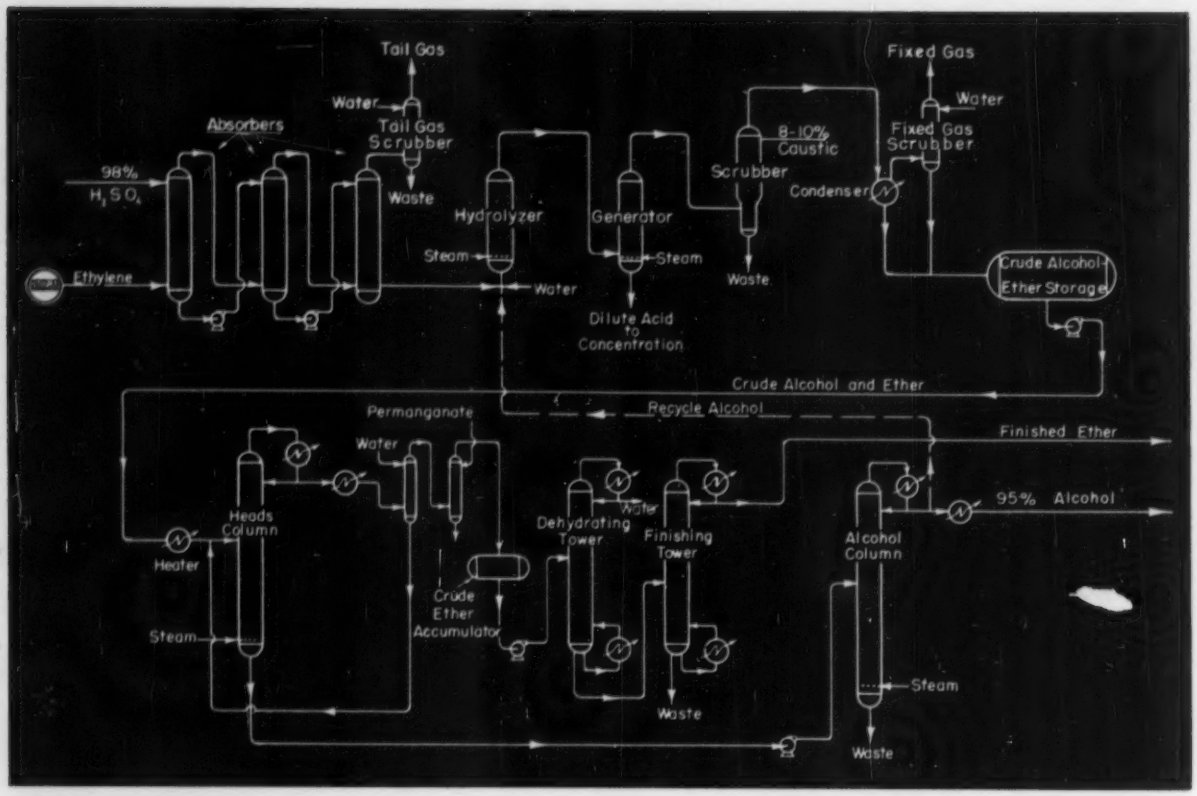
Operating Conditions: The conditions for the ethylene hydration reaction are as follows:

Reaction temperature	570 F.
Reaction pressure	1000 psig.
Reactor feed ethylene concentration, water free basis	85 percent
Ethylene make-up concentration	97 percent
Water-to-ethylene molal ratio in feed	0.6
Space velocity, VSVM	30
Ethylene conversion per pass	4.2 percent
Water conversion	7.0 percent

Yields: Over-all process yield, ethylene to alcohol, is 97 percent or better.

Commercial Installations: This process or a variation is used by Shell Chemical Company at Houston and by British Petroleum Chemicals, Ltd., at Grangemouth, Scotland.

Reference: *Chemical Engineering Progress*, Oct.'54.



Ethyl Alcohol and Ethyl Ether

Application: The esterification-hydrolysis process for the manufacture of ethyl alcohol and ethyl ether.

Charge: Ethylene-rich gas (35-95 percent C_2H_4); concentrated sulfuric acid (98 percent strength).

Products: Ethyl alcohol, 95 volume-percent purity; ethyl ether, 99 weight-percent purity.

Description: A plant designed to produce both ethyl alcohol and ethyl ether by this process can be operated for primary production of alcohol and produce only 5-10 percent of ether or for primary ether production and make little or no alcohol.

The first step is the reaction of sulfuric acid with the ethylene gas stream to form a mixture of ethyl- and diethylsulfates. The size of the absorber varies inversely with acid concentration, ethylene content of the charge gas, and operating pressure. For operating pressures as low as 100 psig and for dilute gas, more than one tower may be required. Internal cooling coils are provided to maintain operating temperatures in the range of 130-170 F.

The absorber tower products flow to the bottom of the hydrolizer where hydrolysis takes place producing alcohol and sulfuric acid. If ether production is desired the alcohol is recycled to the hydrolyzer for longer residence time. The reactions are:

$$C_2H_5OH + C_2H_5HSO_4 \longrightarrow C_2H_5OC_2H_5 + H_2SO_4$$

$$C_2H_5OH + (C_2H_5)_2SO_4 \longrightarrow C_2H_5OC_2H_5 + C_2H_5HSO_4$$

For full ether production, residence times on the order of three hours and temperatures as high as 250 F. are required. The hydrolyzer is a lead-lined steel vessel with inner layer of acid-proof brick.

The hydrolyzate, is pressured to the generator where ether, alcohol, and water are stream stripped from the acid. The dilute acid is sent to concentration. The overhead product passes to a caustic scrubber for neutralization of the sulfuric acid. The generator is of acid proof construction and the scrubber is monel lined. The vapors from the scrubber are condensed and non-condensibles further scrubbed and these combined solutions sent to crude alcohol-ether storage.

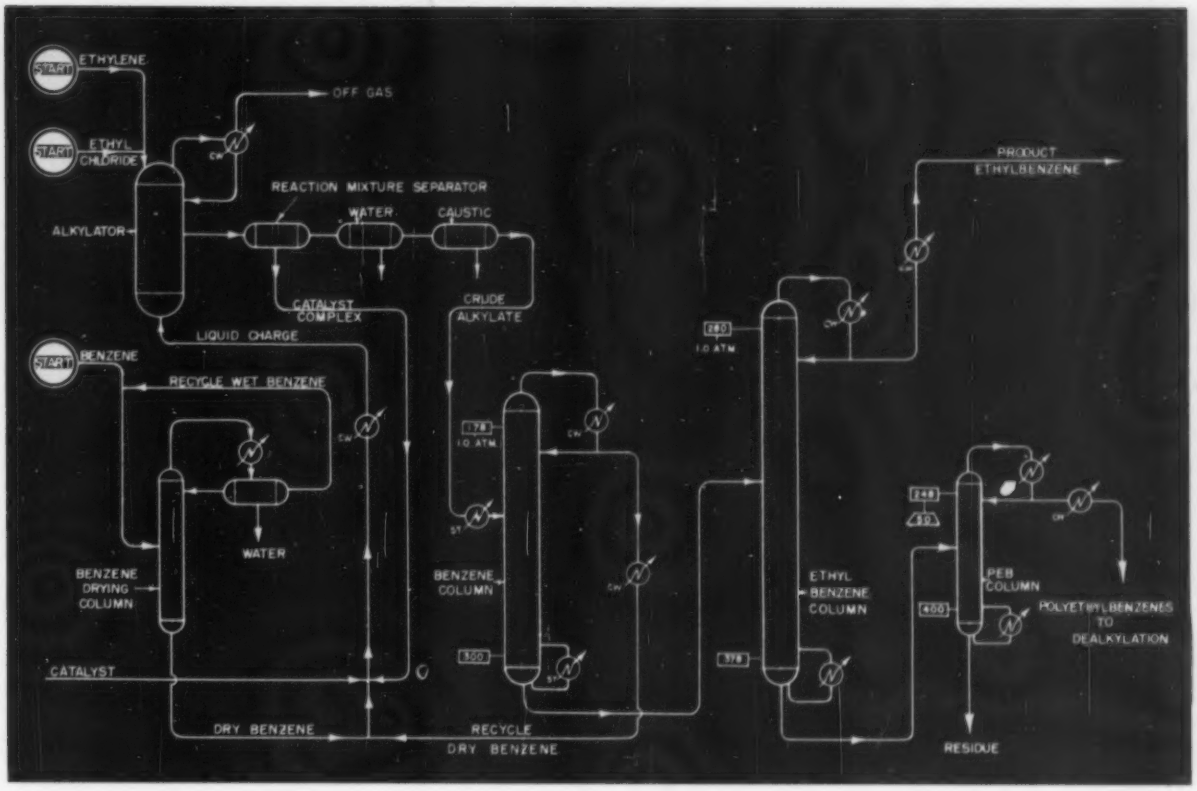
This crude mixture is separated in a heads column, the bottoms going to alcohol column and the overhead going to water wash and permanganate contact and then to crude ether storage.

The ether is finished in a dehydrating tower and a finishing tower. The alcohol is distilled to commercial ethyl alcohol in the alcohol column.

Operating Conditions: These conditions vary with the primary product desired. Some of the ranges are given in the above text.

Yields: 90 percent over-all process yield, alcohol from ethylene.

Commercial Installations: This process or a variation is used at the following plants: Carbide and Carbon Chemicals Co., South Charleston, W. Va., Texas City, Texas, Whiting, Ind.; Esso Standard Oil Co., Baton Rouge, La., Linden, N. J.; National Petro-Chemicals Co., Tuscola, Ill.



Ethylbenzene

Application: A process for manufacturing ethylbenzene.

Charge: Ethylene gas (90-95 mole-percent purity), benzene (stvrene grade), anhydrous aluminum chloride, ethyl chloride.

Product: Ethylbenzene liquid (99.5+ percent purity), primarily for use in styrene manufacture.

Description: Benzene of about 99-percent purity is pumped from storage to the drying column where water is removed by azeotropic distillation. Dry benzene contains a maximum of 30 ppm water. This material is mixed with "catalyst complex" and makeup catalyst to form the alkylator charge. The hydrogen chloride, which serves as a promoter, is supplied indirectly from ethyl chloride which is mixed with the ethylene feed.

The "catalyst complex" consists of a mixture of heavy organics and the catalyst, solid anhydrous aluminum chloride of 97-98 percent purity. It is separated from the reaction products and recycled for its catalyst value. In the alkylator ethylene and benzene react to form ethylbenzene. Ethylene gas contacts the charge of benzene, catalyst, and complex in the alkylator at a temperature of 200 F. and a pressure slightly above atmospheric. Ethylene conversion is near-quantitative.

The alkylator is usually a conventional stirred reactor or a packed tower. The reaction is exothermic and means for heat removal must be provided. Conversion of benzene to ethylbenzene is 30-40 percent per pass.

The alkylator effluent is separated from the heavier catalyst complex. It is then washed with water and caustic in separate steps.

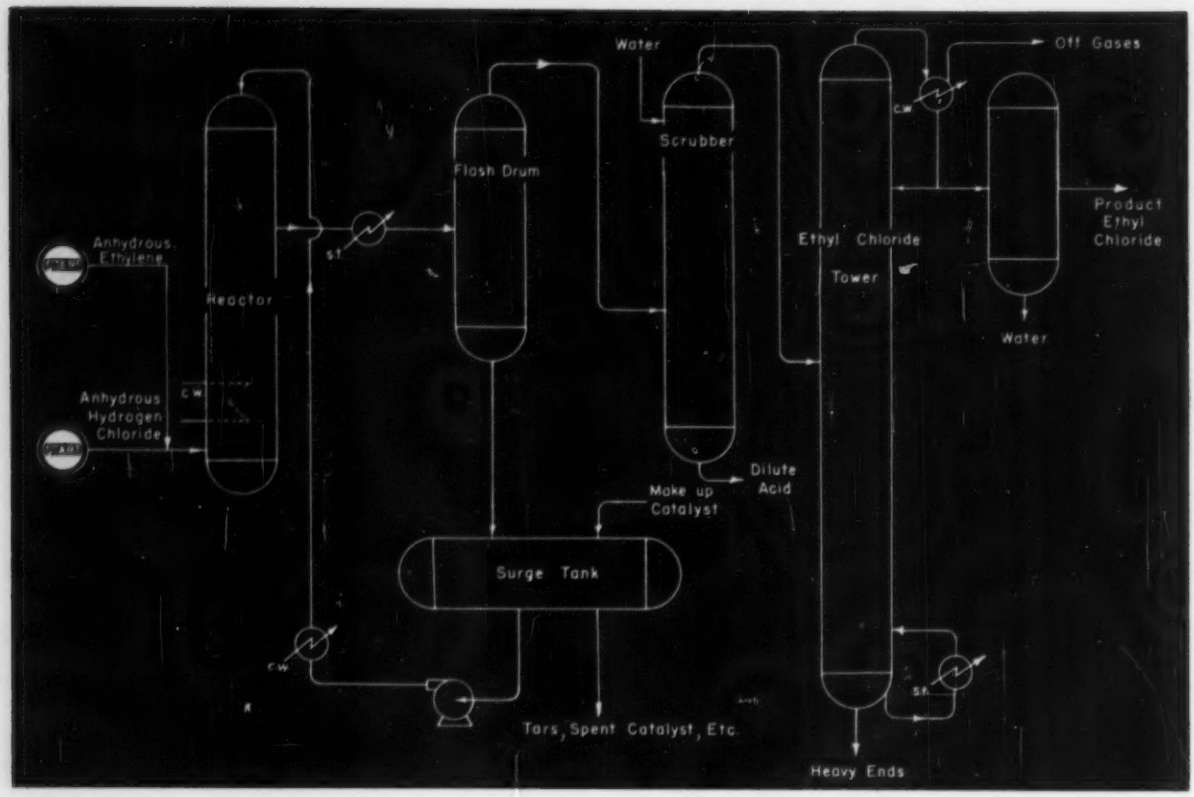
The crude alkylate contains 40-45 percent benzene, 15-20 percent higher-ethylbenzenes, a small amount of tar, and the remainder ethylbenzene. Separation is carried out in a train of conventional fractionating columns. The arrangement of towers described here is only one of several in commercial use. The first column, operating at atmospheric pressure, removes benzene overhead. The bottoms stream passes to the second column in which product ethylbenzene is removed as the overhead stream. This column is usually operated at atmospheric pressure. The third column operates at a head pressure of about 50 mm Hg absolute and removes an overhead product of higher-ethylbenzenes. This material is reprocessed in a dealkylation step.

Over-all process yields are maintained at a high level by the dealkylation step (not shown on the flow diagram) which is similar to the alkylation step, except that higher reaction temperatures and different catalyst ratios are used. The higher-ethylbenzenes are broken down to benzene, ethylbenzene, and diethylbenzene.

Yields: Typical over-all process yields are as follows:

Benzene to ethylbenzene	96 percent
Ethylene to ethylbenzene	97 percent

Commercial Installations: Ethylbenzene units using this process or a variation are found as parts of the several styrene monomer plants throughout the country. Koppers Company recently installed a separate ethylbenzene unit in Port Arthur, Texas.



Ethyl Chloride

Application: This is a process for the production of pure ethyl chloride.

Charge: Hydrogen chloride (anhydrous) and ethylene (90-95 percent).

Product: Ethyl chloride, 99 percent minimum purity.

Description: Anhydrous hydrogen chloride and dry ethylene are mixed in approximately equal molecular proportions and charged to the reactor. A frequent source of ethylene for this process is the purge gas stream from a polyethylene unit. The mixed gases at 95-100 F. enter the vertical reactor and pass upward through the catalyst solution, which is a mixture of aluminum chloride in ethyl chloride or in a higher-boiling chlorinated solvent. The hydrochlorination reaction is exothermic and the heat is removed by cooling coils immersed in the reacting mass. A pressure of about 40 psi is required to maintain the reaction products in the liquid phase. The conversion of both reactants is essentially complete and the yield of ethyl chloride is about 90 percent.

The excess liquid in the reactor overflows into a heater and thence to a flash drum. The vapor, equivalent to the net production of ethyl chloride when the product is used as a reaction medium, or to the total production when another solvent is used, is passed to the purification system. The liquid is pumped to a surge tank where aluminum chloride is added as catalyst makeup and the fresh, cooled mixture is pumped to the reactor.

The vapor from the flash drum is primarily ethyl chloride with minor amounts of methane, ethylene, hydrogen chloride, and heavier chlorinated hydrocarbons. A water scrub removes the hydrogen chloride and the organic vapors are fed to the ethyl chloride product tower. In this tower, the non-condensable gases are vented and ethyl chloride and water are the overhead product. The product is dried by decantation and sent to storage.

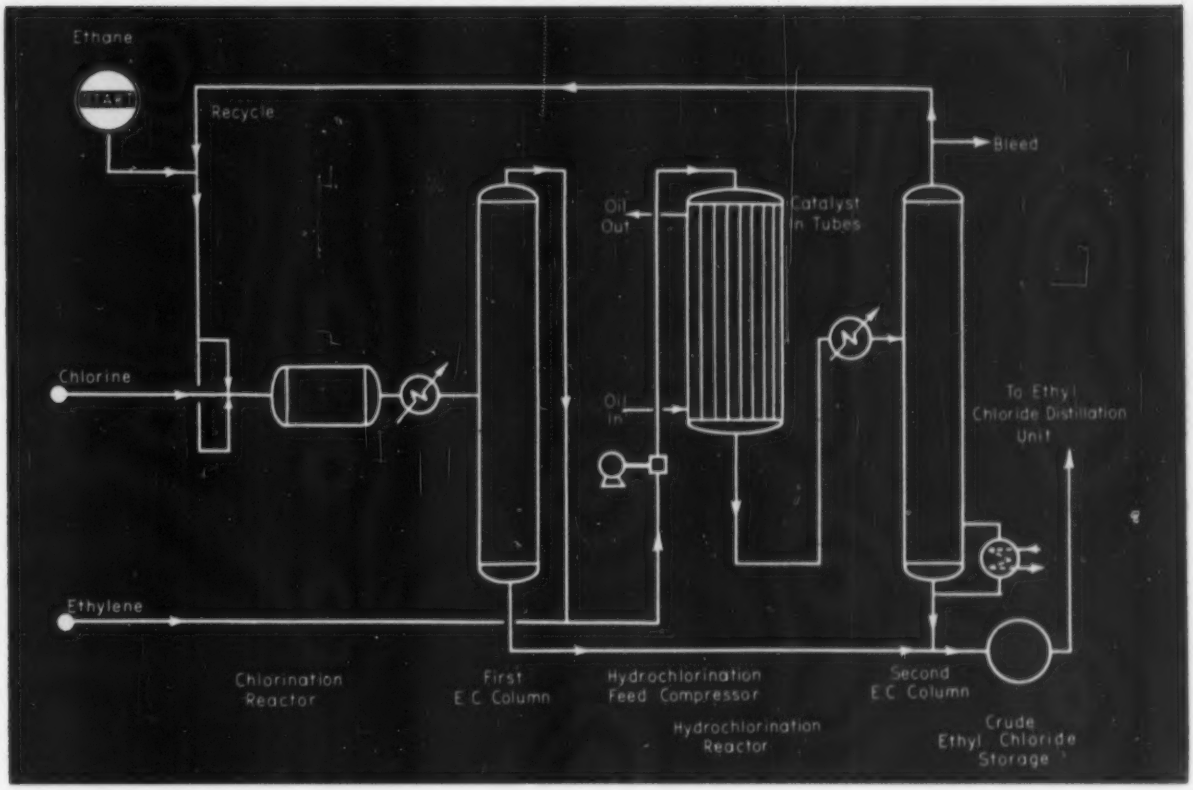
One unique feature of the process is the ease of integration with polyethylene operations. Purge gas from the polymer plant is normally of sufficiently high purity for ethyl chloride manufacture, while the HCl is easily made by direct combustion of chlorine with by-product hydrogen from the cracking plant for ethylene. For these reasons ethyl chloride is becoming a frequent co-product of polyethylene.

Operating Conditions: The reaction conditions given represent a compromise between unfavorable equilibrium conversions at higher temperatures and slow reaction with incomplete conversion at lower levels. The pressure is needed only to maintain the liquid state in the reactor.

Yields: The over-all yields of ethyl chloride is about 90 percent.

Commercial Installations: This process or variations is in use at the following plants: Ethyl Corporation, Baton Rouge, La., Deer Park, Texas; Dow Chemical Company, Midland, Mich., Freeport, Texas; and National Petrochemicals, Tuscola, Ill.

Reference: Petroleum Refiner, Dec.'54,p.136.



Ethyl Chloride (Direct Chlorination)

SHELL DEVELOPMENT COMPANY

Application: A combination of substitutive chlorination of ethane and hydrochlorination of ethylene for the manufacture of ethyle chloride.

Charge: Ethane, chlorine and ethylene.

Products: Ethyl chloride.

Description: Chlorine, ethane and recycle gas stream containing ethylene are fed to the chlorination reactor. The combined ethane and recycle are pre-heated. The chlorine enters as a vapor. The reaction is exothermic and is carried out adiabatically. The reactor exit stream is cooled and sent to the first ethyl chloride column where the inerts, unreacted ethane, hydrogen chloride and some of the ethyl chloride are taken overhead. The remainder of the ethyl chloride and other chlorinated by-products leave as bottom product and are sent to crude ethyl chloride storage.

The overhead stream from this first column plus fresh ethylene is compressed, preheated and fed to the hydrochlorination reactor, where 50-80 percent of the ethylene and the hydrogen chloride combine. In this reaction, temperature is a more important variable than it is in chlorination, and the reaction is carried out isothermally, heat being removed by circulating oil.

The hydrochlorinator exit stream is cooled and fed to the second ethyl chloride column where crude ethyl chloride is taken out as bottoms and sent to crude ethyl chloride storage. The overhead consisting of ethane, inerts, unreacted ethylene and hydrogen chloride is recycled to the chlorinator. It is necessary to vent a portion of this stream to prevent buildup of inerts. The crude ethyl chloride is fed to the ethyl chloride distillation unit, where it is purified in a straight-forward manner by passing first through a heavy-ends column and then through a light-ends column.

In the chlorination reaction, the chlorine disappears completely. Some of the ethylene reacts, but some ethylene is formed by ethyl chloride cracking. Moles of HCl formed exceed slightly the moles of chlorine fed.

In the hydrochlorination reaction the addition of fresh ethylene to the gas stream from the first ethyl chloride column is automatically controlled so that the ethylene-to-hydrogen chloride feed ratio is 1:1. This ratio is not critical, but 1:1 appears to be optimum. Since one mole of ethylene reacts with one mole of hydrogen chloride, the ethylene-hydrogen chloride ratios in the reactor exit, recycle and vent gas streams are also 1:1.

Reactions: The ethane chlorination reaction in this process is carried out in the presence of ethylene at or above 750 F. It produces ethyl chloride and hydrogen chloride:

$$Cl_2 + C_2H_6 \rightarrow C_2H_5Cl + HCl$$

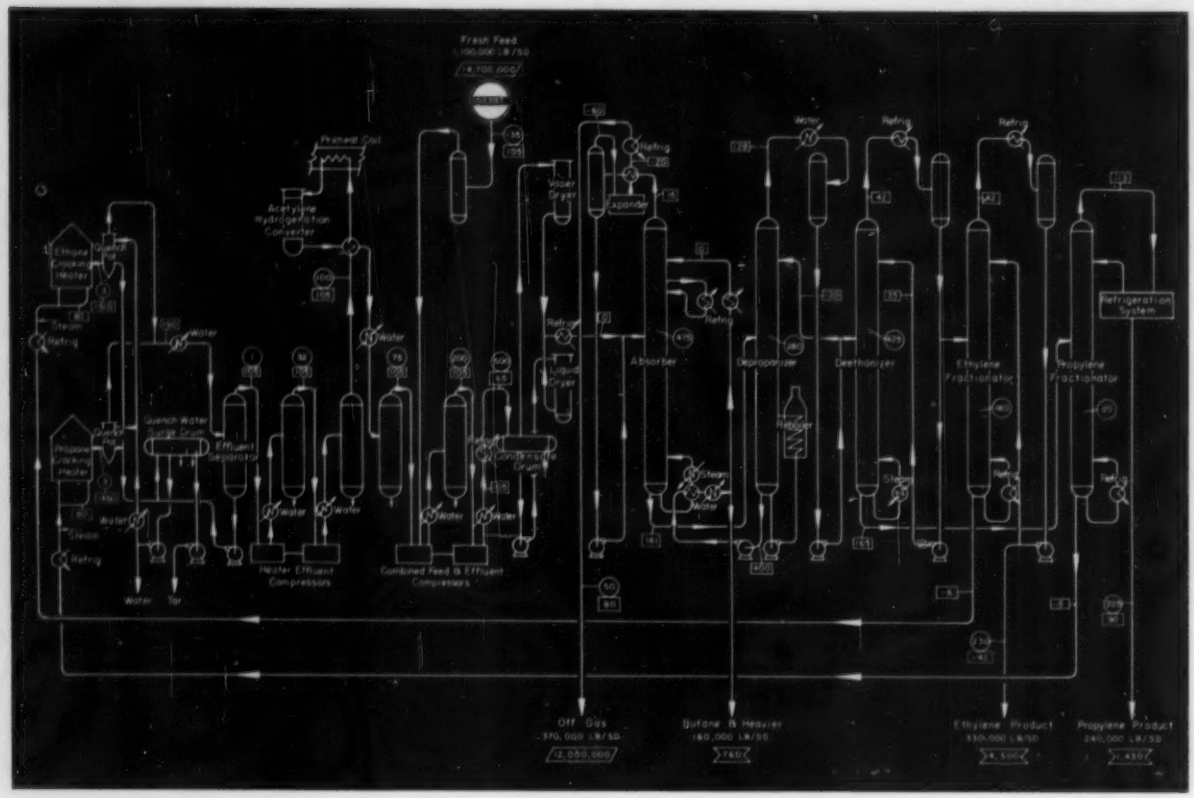
The hydrogen chloride produced in the chlorination reaction is used in the ethylene hydrochlorination reaction which is carried out in the vapor phase at elevated pressure in a reactor packed with catalyst:

$$HCl + C_2H_4 \xrightarrow{\text{Catalyst}} C_2H_5Cl$$

Yields: 90 percent over-all yield, ethane plus ethylene to ethyl chloride and 95 percent chlorine to ethyl chloride.

Commercial Installation: Associated Ethyl Co., Ltd., Ellesmere Port, Cheshire, England.

Reference: *Industrial and Engineering Chemistry*, Vol. 47,No.5,May'55.



Ethylene and Propylene

THE LUMMUS COMPANY

Application: A process for the production, recovery and purification of ethylene and propylene.

Charge Stock: Refinery gases, ethane or propane.

Products: Ethylene and/or propylene at the desired purity up to 99.9-mole percent.

Description: The flow diagram illustrates a plant to produce ethylene and propylene from ethane and propane, and to recover these olefins.

Ethane and propane entering as fresh feed plus unconverted ethane and propane are recovered to provide the feed to the cracking heaters.

Separate furnaces are used for cracking ethane and propane in order that each be cracked at the optimum conditions for maximum yield and on stream time. The effluent from the furnaces are quenched with water in separate quench pots to 190 F., combined, and further cooled in shell and tube units before introduction to the compression system. Polymer and aromatic distillates are collected in the quench water surge drum and decanted there.

The combined heater effluent and fresh feed is compressed to approximately 500 psig, chilled, and dried over solid desiccants such as activated alumina or bauxite. The feed is chilled to a point just above the hydrate formation point to keep the drier load to a minimum.

The dried feed is further chilled and introduced into the fractionating absorber. Hydrogen and methane are rejected essentially completely as off-gas, while the ethylene and heavier components are absorbed in the lean oil. In the plant described the lean oil consists of a fraction consisting of C_4 through aromatic distillate. The fat oil is delivered from the bottom of the absorber with a methane concentration referred to ethylene of less than 1 percent and containing over 96 percent of the ethylene in the absorber feed.

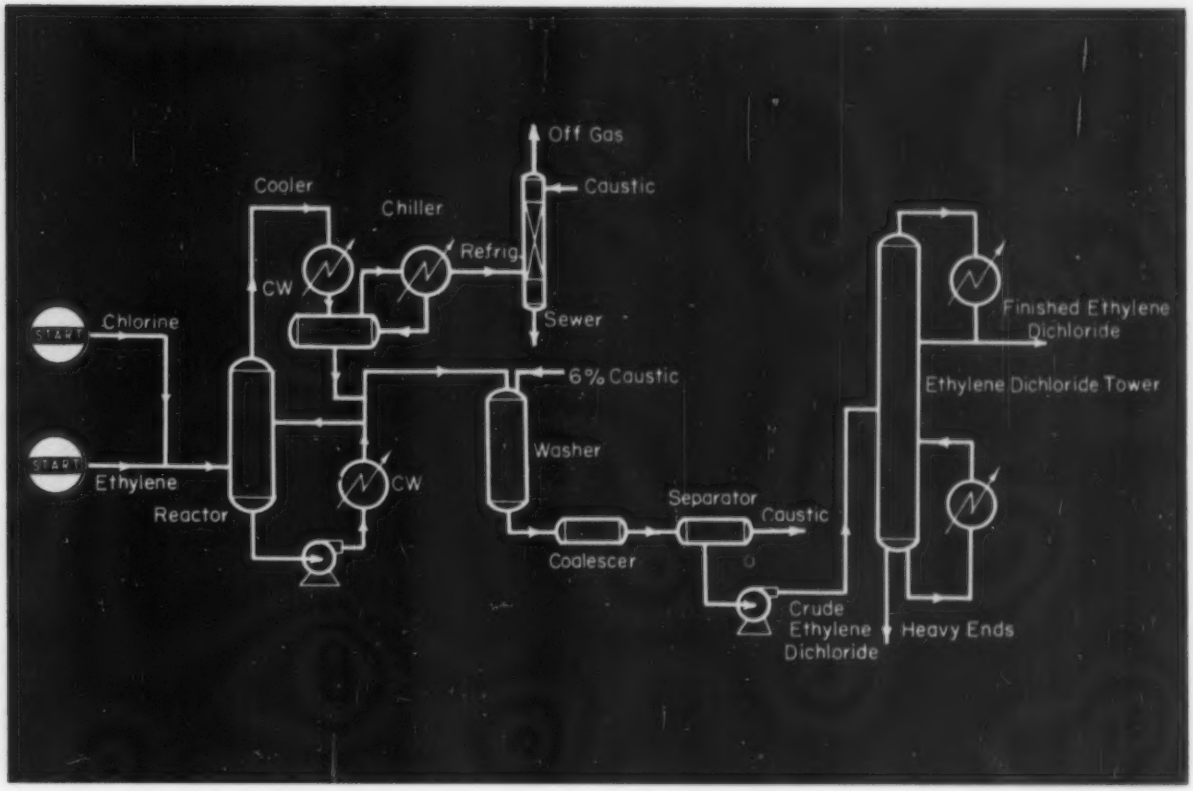
The absorber bottoms are fed to the depropanizer where ethylene, ethane, propylene and propane are taken overhead and the bottoms are recycled as lean oil. The deethanizer splits propane-propylene and ethane-ethylene fractions. The ethylene fractionator splits ethylene overhead and ethane bottoms which is recycled to cracking heaters. For higher purity ethylene a demethanizer is added ahead of the ethylene fractionator. The deethanizer bottoms are similarly separated in the propylene fractionator into the propylene product and a propane bottoms which is recycled.

Refrigeration for the unit is supplied by centrifugal compressors using propane as the refrigerant.

Yield: Approximate yields are shown on the flow sheet. Yields vary with composition of feed stock, conversion per pass in heater and whether propylene is recycled to heater to any extent.

Commercial Installations: The Lummus Company has designed and constructed ten units producing ethylene and/or propylene from various feed stocks.

Reference: PETROLEUM REFINER, July'54,p135.



Ethylene Dichloride

Application: A process for the manufacture of ethylene dichloride (1,2 dichloroethane).

Charge: Chlorine, 99+ percent purity; ethylene-rich gas.

Product: Ethylene dichloride, 99+ percent purity.

Description: Ethylene dichloride is produced commercially by the chemical combination of ethylene and chlorine. The ethylene may contain diluents such as hydrogen and methane, but in general should contain no impurities heavier than propane. Frequently, the ethylene has a purity of 90 percent or better.

Ethylene and chlorine are blended in a molar ratio of 1.05-1.10 to 1.00 and charged to the reactor. The reaction takes place in the liquid phase in the presence of a considerable excess of reaction products. The exothermic heat of reaction is removed by circulating the reaction mixture through an external heat exchanger (other means for heat removal, such as internal coils and jacketed walls, may be used). When the ethylene charge is of high purity, the reaction is quite rapid, and the design of the reactor not overly critical. In general, the reactor is a vertical steel vessel half-filled with ethylene dichloride. When inert gases are present, packing or other means may be used to improve gas-liquid contact. Gases are admitted through sparger pipes at the bottom of the vessel.

The reactor contents are maintained at 100-120 F. The operating pressure for a high-purity ethylene charge is on the order of 10-20 psig, but may be higher for more dilute ethylene charge streams. The yield of ethylene dichloride from chlorine is 90-95 percent. The side products include hydrogen chloride, propylene dichloride, and polychloroethanes. It is sometimes feasible to add small amounts of materials such as ferric chloride or ethylene dibromide to increase the yield of ethylene dichloride.

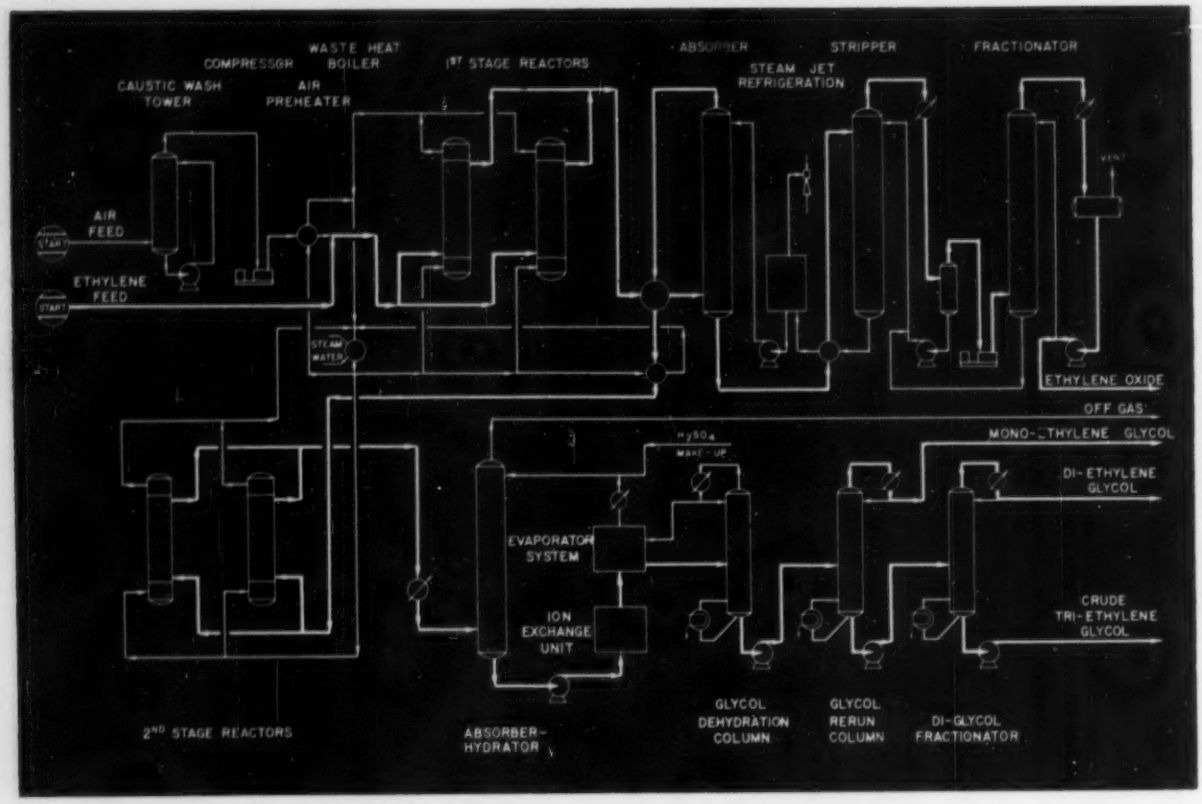
Both vapor and liquid products are removed from the reactor. The vapors pass to water-cooled and refrigerated exchangers for the recovery of ethylene dichloride, and thence to a scrubbing tower where hydrogen chloride is removed with dilute caustic. The vapors finally issuing from the vent contain hydrogen, methane, ethylene, and ethane.

The liquid products from the reactor are washed with 6-8 percent caustic in an agitated vessel. They then pass through a coalescer to a separator tank where the lower layer of crude ethylene dichloride is withdrawn.

Final purification of the ethylene dichloride is accomplished in a conventional atmospheric distillation column. The finished product has a purity of 99+ percent, and is stored in steel containers.

Yields: Over-all process yield of ethylene dichloride from chlorine is 90-95 percent.

Commercial Installations: This process or a variation is used at the following plants: Carbide and Carbon Chemicals Co., South Charleston, W. Va. and Texas City, Texas; Dow Chemical Co., Freeport, Texas and Midland, Mich.; Ethyl Corporation, Baton Rouge, La. and Houston; Monsanto Chemical Co., Texas City; Diamond Alkali Co., Deer Park, Texas.



Ethylene Oxide and Ethylene Glycol

STONE & WEBSTER-BADGER

Application: The process produces ethylene oxide by the direct oxidation of ethylene over a silver catalyst. The ethylene oxide is recovered as a pure product or hydrated to ethylene glycols.

Charge: High purity ethylene and air or oxygen.

Products: High purity ethylene oxide, mono and diethylene glycols and polyglycols.

Description: The air is scrubbed with caustic to remove impurities harmful to the catalyst and compressed to reactor operating pressure. It is then preheated by exchange with Dowtherm from the reactor cooling system, mixed with the ethylene feed and charged to the first stage reactors. The reactor effluent is immediately cooled and passed to an absorber where the ethylene oxide is scrubbed out with water. The rich solution flows to a stripper where the oxides are released overhead. The stripped gases are compressed and passed to a fractionator where ethylene oxide meeting commercial specifications is recovered. Water from the bottom of the stripper is cooled by exchange and subcooled by steam jet refrigeration before its return to the absorber.

The gases from the first oxidation stage are brought again to reaction temperature level by heat exchange with the reactor coolant and charged to the second stage reactors operating at a somewhat higher temperature than the first stage reactors in order to effect high conversion of the remaining ethylene. The reactor effluent is cooled and passed to the hydrator for the catalytic hydration of the oxide to ethylene glycols in dilute solution.

The glycol solution is passed through an ion exchange unit to remove the acid catalyst, and the glycols are concentrated by multiple effect evaporation. The glycol concentrate is then subjected to distillation in a series of fractionating columns; the first removing residual water which is recycled to the evaporators; the second recovering monoethylene glycol as overhead; and the third recovering diethylene glycol as overhead product and the higher glycols as a bottom stream.

The key to the successful operation of this process lies in close temperature control of the reaction and in proper allowance in the reactor design for piston flow and the rate controlling processes of diffusion.

The principal reactions occurring are:

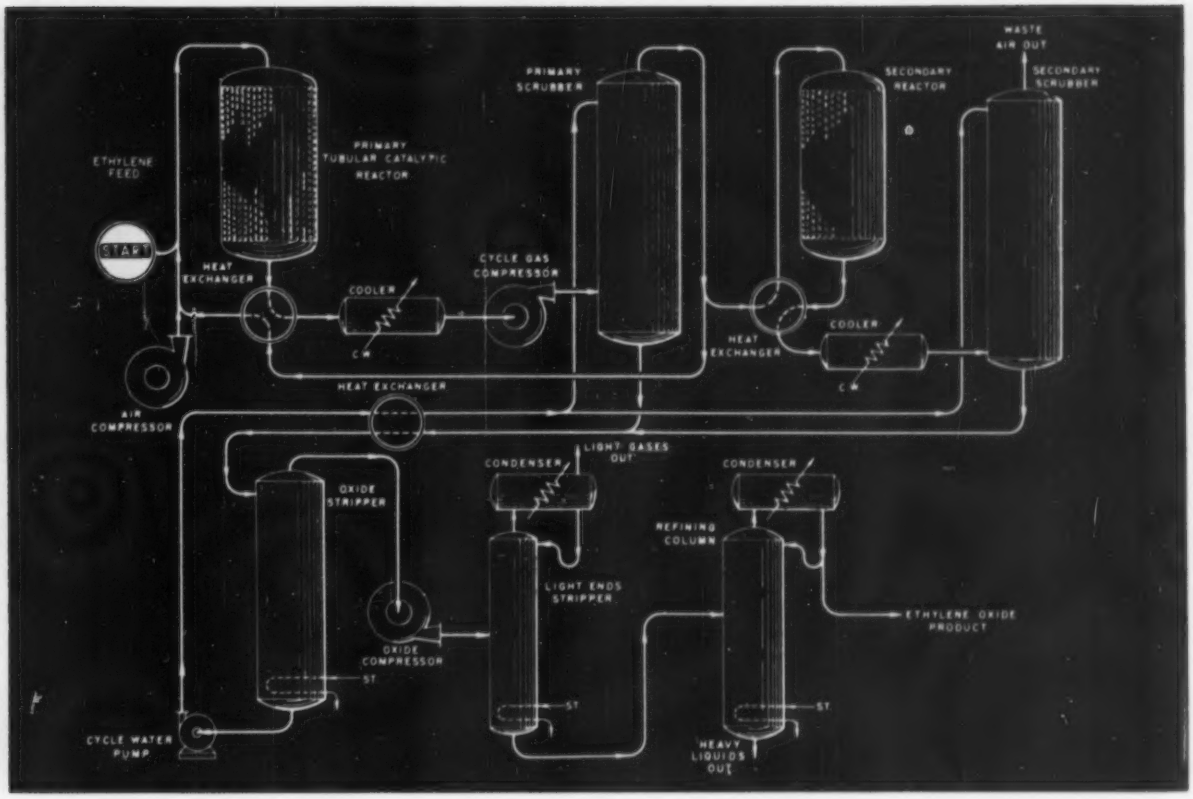
$$C_2H_4 + 3\,O_2 \longrightarrow 2\,CO_2 + 2\,H_2O\ (g) + 570{,}000\ \text{Btu/mole}$$
$$C_2H_4 + \tfrac{1}{2}\,O_2 \longrightarrow C_2H_4O\ (g) + 63{,}000\ \text{Btu/mole}$$

The oxidation catalyst is the Cambron silver catalyst developed by the National Research Council of Canada over the last decade. It has a long life and can be reactivated if accidental poisoning occurs. The catalyst activity is not affected by repeated interruption of operation.

Operating Conditions: The first stage reactors operate at about 500 F., and the second at about 525 F.

Yields: Over-all conversion of ethylene to ethylene oxide is about 63 percent, with a total conversion of ethylene of about 95 percent. Glycol yields depend on the desired conversion of ethylene oxide to glycols.

Commercial Status: The process has been evaluated in the pilot plant and commercial plant design factors have been established.



Ethylene Oxide

SCIENTIFIC DESIGN COMPANY, INC.

Application: A process for the manufacture of ethylene oxide.

Charge: High purity ethylene and air.

Product: High purity ethylene oxide, liquid.

Description: Compressed air, ethylene, and recycle gas are mixed and fed to a multi-tubular, catalytic reactor. The temperature of oxidation is controlled by an organic cooling medium which is omitted on the process flow diagram. From the reactor the effluent gases, which contain ethylene oxide, are cooled and further compressed. The cooling is accomplished first by recuperative exchange with the recycle gases, and finally by a water cooled exchanger. The gases then pass to a scrubber where ethylene oxide is absorbed in a dilute aqueous solution. Most of the unabsorbed gases are returned to the reactor via the previously mentioned recuperative exchanger, thus completing a closed circuit. A portion is diverted to the secondary reactor, to purge accumulated inert gases. The secondary reactor operates to scavenge the remaining ethylene. From the secondary reactor the effluent gases are cooled as before. The ethylene oxide is absorbed in a scrubber, and the residual gases are discharged from the system.

The dilute solution of ethylene oxide is stripped by heat. A feed-bottoms exchanger is usually employed to save steam. The overhead vapor, which contains a substantial amount of water vapor, may be passed through a partial condenser for enrichment. This partial condenser is omitted on the flow diagram, because it is not essential and because of space limitations. Oxide vapor is compressed and refined in a distillation train. There are several alternate arrangements for the distillation. As shown here, the carbon dioxide and other light ends are first stripped out of the oxide, and then pure oxide is distilled away from water and other heavier liquids. The pure ethylene oxide product is pumped as a liquid to storage tanks which are padded with inert gas.

The catalyst contains silver. Its long life and durability make catalyst costs a relatively unimportant item in the ethylene oxide manufacturing budget. The reactions involved are simple:

(1) $C_2H_4 + \frac{1}{2} O_2 \rightarrow C_2H_4O$

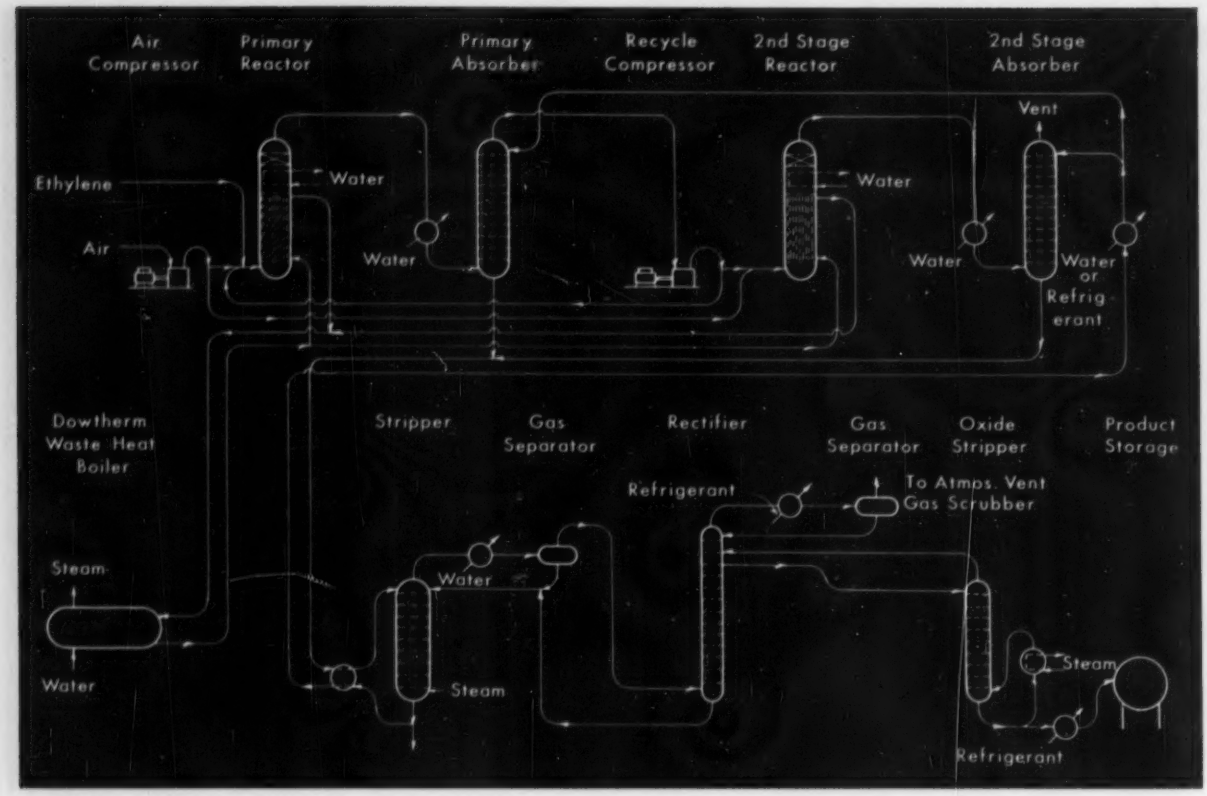
(2) $C_2H_4 + 3 O_2 \rightarrow 2 CO_2 + 2 H_2O$

Operating Conditions: Oxygen and ethylene concentrations in the reaction gases are quite critical. In order to avoid explosion hazards, they must be maintained at a low level. Reaction temperatures range between 450 F and 600 F. The reaction pressure may vary between 120 and 300 psig. Distillation conditions are usually determined by the available cooling water temperature.

Yields: The weight yield, expressed as pounds of ethylene oxide produced per pound of ethylene consumed, approaches one hundred percent, in plants of the proper design.

Commercial Installations: Three plants have been built utilizing the Scientific Design Company process, of which two are currently in operation. Napthachimie operates a recently expanded plant to Lavera, France. Nitrogen Division of Allied Chemical and Dye Corporation operates a plant at Orange, Texas. The Societe Chimique des Derivees du Petrole, is constructing a plant in Belgium.

References: PETROLEUM REFINER, Sept.'53,p.146; *Chemical Engineering*, Aug.'54,p.130.



Ethylene Oxide

THE ATLANTIC REFINING COMPANY
THE VULCAN COPPER & SUPPLY COMPANY

Application: A process for making ethylene oxide.

Charge: Ethylene of 95+ percent purity.

Product: Ethylene oxide of 99.5 percent purity.

Description: Ethylene oxide is made by the direct oxidation of ethylene. Ethylene and air are mixed with recycle gas and passed through a multitube reactor, each tube of which is filled with a fluidized silver catalyst. The tubes are kept full by a layer of catalyst held above the tube sheet. Specially designed orifices assure equal gas distribution. A dowtherm system removes the heat of reaction and gives the required close temperature control. The dowtherm vapors when condensed form steam for the process. The reaction is quenched right after the catalyst bed by internal cooling coils. Filters remove any entrained catalyst from the gases. After further cooling the gases flow to the primary absorber where they are scrubbed with water to extract the ethylene oxide.

The oxide-free gas is recompressed. Part of the stream is recycled to the primary reactor, and part, with a small amount of air added, is fed to the second stage reactor. This reactor, of the same design as the primary, is operated on a once through basis. Exit gases are cooled and then scrubbed with water in the second stage absorber. The oxide-free gas may be vented or go to a third stage.

The absorbates from the two absorbers are combined and fed to the top of a bubble cap stripping column after heat exchange with the bottoms-stripped absorbent from the stripper. Stripped absorbent is returned to the absorbers. In the stripper column ethylene oxide and other gases are stripped from the absorbate by open steam. A mixture of ethylene oxide, water and carbon dioxide goes overhead to a partial condenser where water is separated and refluxed to the stripper.

The uncondensed vapors are fed to a rectifying column. The bottoms stream is returned to the stripper as reflux. The overhead stream is partially condensed. The condensate is refluxed, and the uncondensed gases are sent to an atmospheric vent gas scrubber for recovery of any ethylene oxide present in the gas.

A sidestream from the column, containing the ethylene oxide product and carbon dioxide, is fed to the oxide stripper where the carbon dioxide is removed overhead. This stream is returned to the rectifying column, and the bottom stream, the ethylene oxide product, is cooled and sent to storage in spheres under inert gas.

The catalyst is a specially prepared silver catalyst with good fluidization characteristics. No regeneration or reactivation of the catalyst is needed, and in the captive fluid bed no attrition problem has yet appeared. The reactions involved are simple.

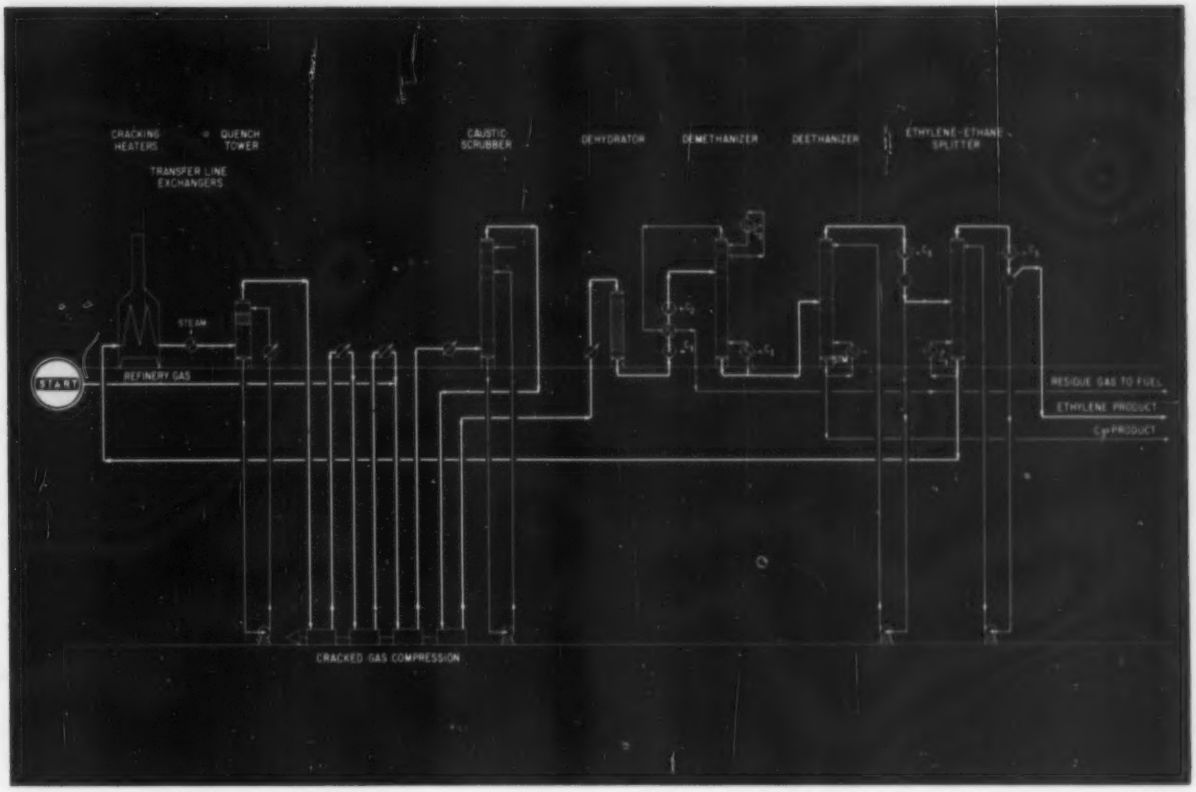
$$(1)\ C_2H_4 + \tfrac{1}{2}\,O_2 \rightarrow C_2H_4O$$
$$(2)\ C_2H_4 + 3\,O_2 \rightarrow 2CO_2 + 2H_2O$$

High temperatures favor reaction (2), and close temperature control is necessary to avoid local hot spots.

Operating Conditions: Reaction temperatures are 400 to 600 F. Pressures are 100 to 150 psig.

Yields: The over-all yield of ethylene oxide is 55-65 percent, based on ethylene. At the present the economic yield is closer to 55 per cent. Conversion in the primary reactor is 35-50 percent and in the second 50-70 percent.

Reference: Petroleum Refiner, Sept.'53,p146.



Ethylene Production

STONE & WEBSTER-BADGER

Application: A process for the production of ethylene from refinery gas, with ethane and propane cracking to supplement the ethylene recovered from the refinery gas.

Charge: Refinery gas, however ethane, propane, or butane may be charged.

Products: The primary product is high purity ethylene. Other products are:

- Residue gas, substantially hydrogen and methane.
- A liquid fraction which may be further fractionated.

Description: The recovery process utilized may be either low temperature fractionation or adsorption, depending on the composition of the feed gas to the recovery section and the quantity of inerts. This description is based on low temperature fractionation with ethane cracking.

Refinery gas is combined with gas from the cracking furnaces and compressed to the pressure required by the demethanizer. This pressure will vary with the concentration of hydrogen and methane and the recovery of ethylene desired. The compressed gas is cooled, dried and fed to the demethanizer wherein methane and lighter components are taken overhead by fractionation at low temperature. Reflux is produced with ethylene refrigerant.

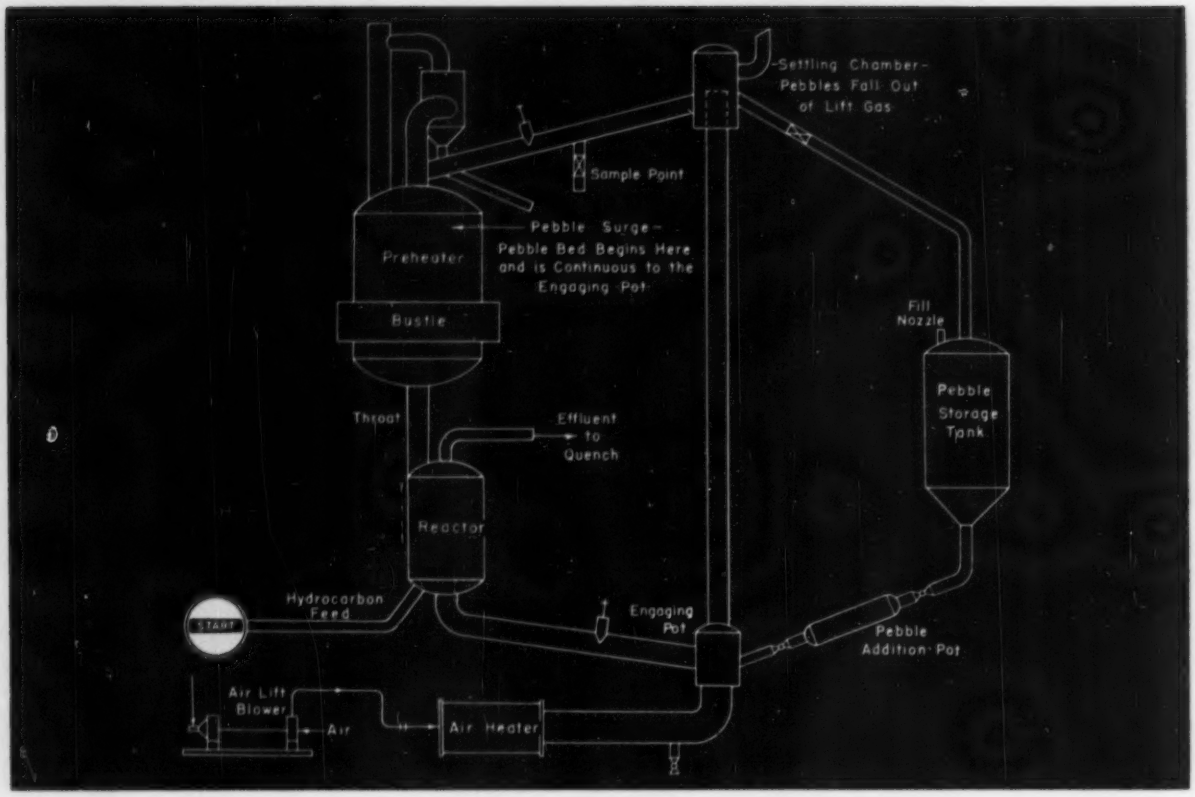
The demethanized bottoms flow to the deethanizer, from which ethylene and ethane are taken overhead, and propylene and heavier discharged as a bottoms stream. This stream may be further separated in a depropanizer, and the recovered propylene-propane cut processed for removal of propylene. The unreacted propane can then be returned to the ethylene unit and cracked to produce additional ethylene. The ethylene-ethane stream is fractionated at low temperature to produce an ethylene product of the required purity and an ethane stream which is vaporized and recycled to the cracking furnaces. Cracking is preformed in a coil-type reactor designed for graduated heat intensity in conformity with a temperature gradient conducive to maximum ethylene yield and minimum coke formation. The furnace effluent is quenched and cooled in a quench tower in which heavy aromatic oil is condensed and separated.

Where an ethylene product with low acetylene content is required, the cracked gas, after compression to an intermediate pressure, is heated and selectively hydrogenated over a catalyst. The gas is then cooled, combined with the refinery gas fresh feed stream and compressed to the final discharge pressure. Refrigeration is by a propane-ethylene cascade system.

Yields: Ultimate yields of ethylene from cracking of C_2 and C_3 are approximately 77 and 45 percent by weight, respectively. Ethylene recovery ranges from 96 to 98 percent. Ethylene product purity normally is in the range of 95 to 99.9 percent.

Commercial Installations: Fourteen plants with a combined production of approximately 3 million pounds per day of ethylene.

Reference: PETROLEUM REFINER, July'54,p135.



Ethylene with Pebble Heater

PHILLIPS PETROLEUM CO.

Application: A heating process for attaining temperatures beyond the range of conventional tube furnaces.

Charge: The charge may be gaseous hydrocarbons, inert or corrosive gases, steam or air. It is primarily C_2 to C_4 hydrocarbons for ethylene manufacture.

Product: Ethylene and other unsaturated hydrocarbons, predominantly olefinic. However, the cracked hydrocarbon effluent depends on the processing conditions, i.e., reaction time, pressure and temperature.

Description: In the Pebble Heater process, continuously circulating refractory balls (pebbles) are contacted directly in a reaction chamber with the charge material to be heated or cracked. As shown by the flow diagram, a continuous bed of pebbles extends from the engaging pot upward through the reactor and preheater vessel into the pebble surge at the top of the preheater. This entire bed of pebbles slowly moves downward through the chambers at a rate controlled by a flow control device in the engaging pot. In the lift line the pebbles travel upward in a stream of heated air. The pebbles settle out of the lift air in an enlarged vessel at the top of the lift line and then run down the sloping line to the top of the bed in the pebble surge. As the pebble bed moves downward in the preheater, the pebbles are heated by an upward flow of hot combustion gases. These hot gases are generated under pressure in the bustle-type combustion chamber surrounding the lower portion of the preheater vessel. The hot pebbles then pass through a restricted throat into the reaction chamber where the upward-flowing gaseous charge is heated. The feed is admitted to the lower portion of the reactor through a distributor designed to minimize interference with the flow of pebbles. The resulting cooled pebbles flow downward out of the reactor through a duct into the engaging pot and are returned through the lift to the settling chamber. When processing hydrocarbons the heated gases pass out the top of the reactor into a quench vessel where the temperature may be quickly lowered by direct water spray.

To prevent the undesirable mixing of combustion gases and reactor effluent, a pressure balance is maintained across the throat between the preheater and the reactor. Further to insure separation of the gases, steam is injected into the throat between the chambers. Between the reactor and the engaging pot a steam seal is used to separate the lift gas from the reactor feed.

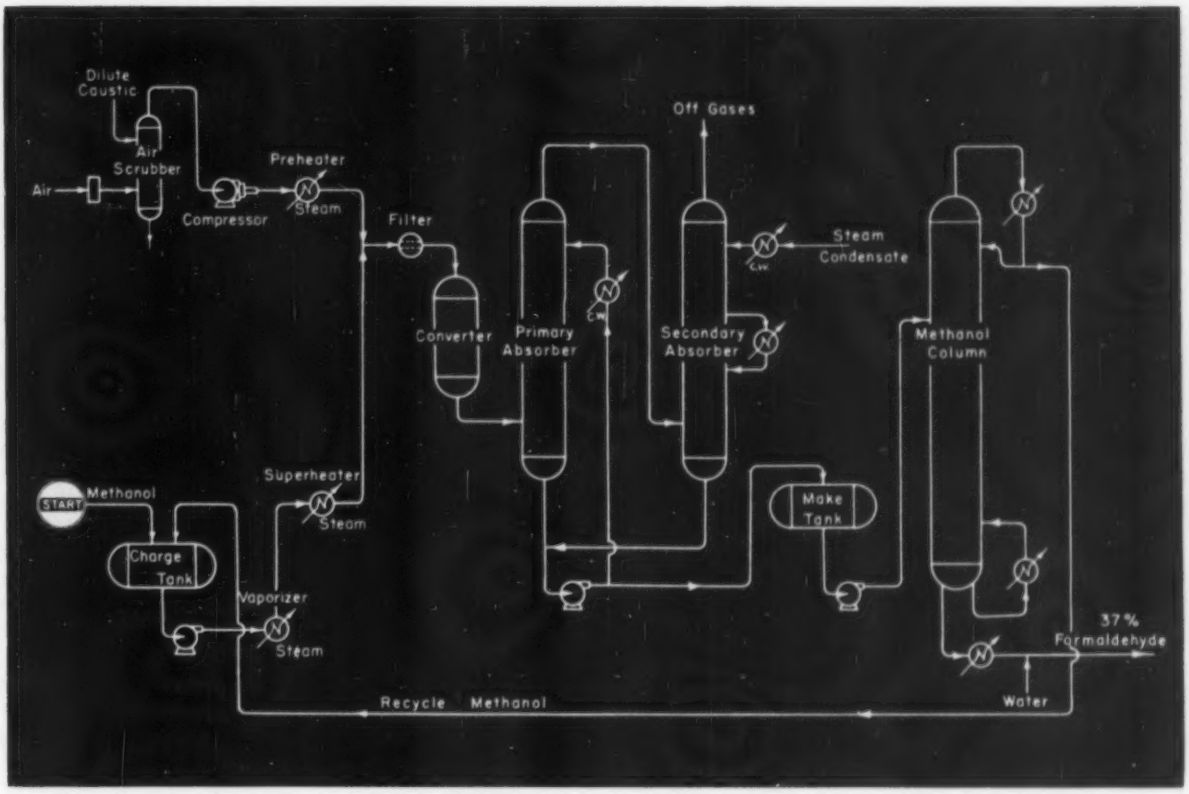
Operating Conditions: The major operating variables for hydrocarbon processing are temperature, pressure and reaction time. For other materials not all of these variables may be significant.

Yields: Typical feed stock and corresponding reactor effluent compositions are as follows:

Feed	(Mol. Percent)	Reactor Effluent	(Mol Percent)
		Hydrogen	45.0
Ethane	91.0	Methane	7.6
Propane	8.9	Acetylene	3.8
Other	0.1	Ethylene	33.3
		Ethane	7.0
	100.0	Heavy Unsaturates	3.3
			100.0

Commercial Installations: Following several years of successful pilot plant operation, Phillips has installed a 30 Mm Btu per hour commercial Pebble Heater at Borger, Texas.

Reference: PETROLEUM REFINER, Apr.'54,p171.



Formaldehyde and Acetaldehyde

Application: A process for manufacturing formaldehyde from methanol or acetaldehyde from ethanol.

Charge: Methanol, 99.8 percent purity and atmospheric air for formaldehyde production. Ethanol and atmospheric air for acetaldehyde production.

Product: Either formaldehyde, 37 weight percent aqueous solution or acetaldehyde, 99 percent purity is produced, depending on the charge.

Description: *Formaldehyde.* Fresh and recycle methanol is vaporized, superheated and then passed to the methanol-air mixer. Atmospheric air is purified, compressed and then pre-heated to 130 F. in a finned exchanger.

Methanol and air are mixed in approximately equal volumetric proportions and are fed to the converter. The simultaneous reactions which occur are:

$$CH_3OH + 1/2\ O_2 \rightarrow HCHO + H_2O + 38\ \text{k-cal.}$$

$$CH_3OH \rightarrow HCHO + H_2 - 20\ \text{k-cal.}$$

The products emerge from the converter at about 1150 F. The converter is a small water-jacketed vessel which contains several layers of silver gauze catalyst. The operating pressure is 5-10 psig.

About 65 percent of the methanol is converted per pass. Oxygen conversion is essentially complete.

The reactor effluent containing about 25 percent formaldehyde is fed to two absorbers in series where cooling and separation occurs using a counter-current stream of methanol and formaldehyde. Rich solutions from both absorbers are combined and sent to the make tank.

The solution is pumped from the make tank to the methanol column where 99 percent methanol is separated overhead and recycled to the charge tank. The bottom stream from this tower is the product and contains from 1-7 percent methanol. Water is added to reduce formaldehyde concentration to 37 weight percent.

Acetaldehyde. Ethanol vapor at 320 F. is mixed with air preheated to 400 F. and passed over a silver gauze catalyst. Simultaneous oxidation-dehydrogenation takes place at 1000 F. to produce acetaldehyde with a yield of 85-90 percent. Conversion per pass of ethanol is about 50 percent. The reactor effluent passes to absorption towers in which alcohol and aldehyde are cooled and condensed by a countercurrent stream of dilute alcohol. The rich liquor is rectified in a series of two columns. In the first, 99 percent acetaldehyde is removed overhead. In the second, 95 percent alcohol is removed overhead and recycled to the reactor.

Yields: Over-all process yields of formaldehyde and acetaldehyde based on charge stock, are 85-90 and 85-95 percent, respectively.

Commercial Installations: This type of process or a variation is used at the following plants: Bakelite Corporation, Bound Brook, N. J.; Commercial Solvents Corporation, Agnew, Calif.; E. I. duPont de Nemours & Company, Perth Amboy, N. J. and Toledo, Ohio; Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y.; Heyden Chemical Corporation, Garfield, N. J.; Monsanto Chemical Company, Springfield, Mass.; Rohm and Haas Company, Bristol, Pa.; Spencer Chemical Corporation, Calumet City, Ill.

References: Petroleum Refiner, Jan.'55,p147;Feb.'55,p129; Mar.'55,p201.

Glycerol

Application: This process is for the manufacture of synthetic glycerol.

Charge: Propylene, 98 percent purity and chlorine 99+ percent purity are the charge.

Product: Glycerol (glycerine), 99+ percent purity, is the product.

Description: For convenience, the synthetic glycerol process may be divided into three successive operations, the end products of which are allyl chloride, epichlorohydrin, and finished glycerol (termed "glycerine" in commercial practice). A portion of the allyl chloride produced is used in the manufacture of allyl alcohol. Similarly, a portion of the epichlorohydrin produced is used in the manufacture of epoxy resins. Although synthetic glycerol production accounts for a small portion of the nation's total, it serves the very important function of buffering the otherwise-fluctuating price of glycerol.

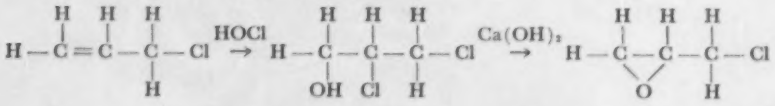
Allyl chloride is produced by the hot chlorination of propylene. Substitution rather than addition of chlorine takes place. This is the most important step in the synthesis and the one which presented most difficulties in the original development.

Fresh liquid propylene is fed to a storage tank where it is blended with recycle propylene in a ratio of about 1:3. The blend is dried over a solid desiccant, preheated to 650-700 F. in a fired tubular heater, and mixed rapidly with cold chlorine gas. The reactor is a simple steel tube which is operated adiabatically. The reaction is exothermic and the products leave at 950 F. The ratio of propylene to chlorine in the feed is 4:1. Conversions of propylene and chlorine are about 25 percent and 100 percent, respectively. The yield of allyl chloride is 80-85 percent. The operating pressure is 15 psig. A certain amount of coking occurs and a multiple-unit arrangement allows periodic de-coking without disturbance of operating continuity.

The effluent gases are cooled quickly to 120 F. in a tubular exchanger and are sent to the prefractionator. Unconverted propylene plus hydrogen chloride are removed overhead. Reflux is dry liquid propylene at —40 F. The overhead gas is scrubbed first with water and then with caustic before being compressed, liquified, and returned to charge propylene storage. A by-product stream of 32 weight-percent HCl is recovered from the water-scrubbing operation.

The bottoms stream from the prefractionator contains about 75 weight-percent allyl chloride. Dichloropropane is the major contaminant. Purification is effected in two conventional fractionators. The first serves to remove the 1-2 percent light ends present in the crude allyl chloride and the second serves to remove dichloropropane and other high boilers. The purified allyl chloride is placed in storage for use in the manufacture of allyl alcohol and glycerol.

Epichlorohydrin is produced from allyl chloride by the following reactions:



Chlorine and water are reacted in a tower to form a solution of hypochlorous acid which is in turn reacted with allyl chloride in a stirred tank to form a mixture of dichlorohydrins. The desired reaction takes place in the aqueous phase, and a minimum of allyl chloride is allowed in the reaction zone in order to avoid side reactions in the non-aqueous (allyl chloride) phase. The reaction is exothermic but readily maintained in the 85-100 F. range by the excess of acid.

The reactor effluent passes to a separator tank where the aqueous phase is removed and recirculated to the chlorinating tower. The non-aqueous phase, containing the mixture of dichlorohydrins, is fed to a stirred reactor where it is contacted with a lime slurry. The reactor contents are maintained below 140 F. Essentially complete conversion to epichlorohydrin is obtained. The product is steam-distilled at atmospheric pressure as a water azeotrope which contains in addition a small amount of unreacted dichlorohydrin. Epichlorohydrin of 98 percent purity is obtained from a final distillation.

Glycerol is formed by the hydrolysis of epichlorohydrin, using sodium hydroxide. Dilute (about 10 percent) caustic is added to the epichlorohydrin in a stirred tank. Essentially complete conversion to glycerol is obtained. The effluent from the tank is a dilute solution of glycerol containing sodium chloride. Salt and most of the water are removed in a multiple-effect evaporation system. At an intermediate point the salt crystallizes and is removed from the bottom of the evaporator. A certain amount of glycerol is recovered from the ensuing settling operation and is recycled to the evaporation system. Reduced pressure is used in the latter stages of the evaporation. Crude glycerol of about 90 percent purity is obtained.

Glycerol of 99+ percent purity is obtained in a final vacuum distillation operation. It is stored in nickel-clad steel tanks and shipped from the plant in aluminum tank cars.

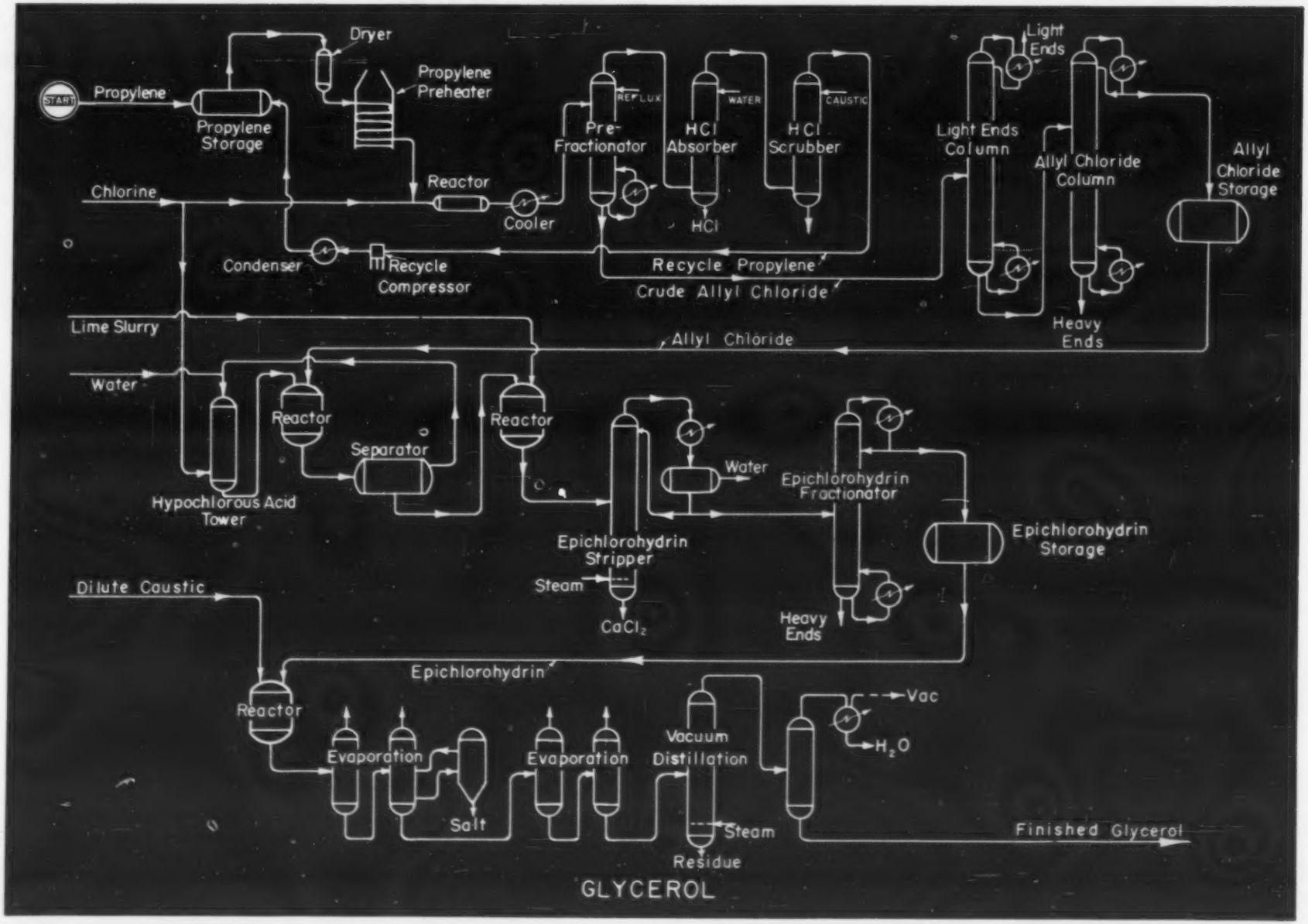
Operating Conditions: The key reaction in the glycerol synthesis is the hot chlorination of propylene. Typical operating conditions for this reaction are given in the above text.

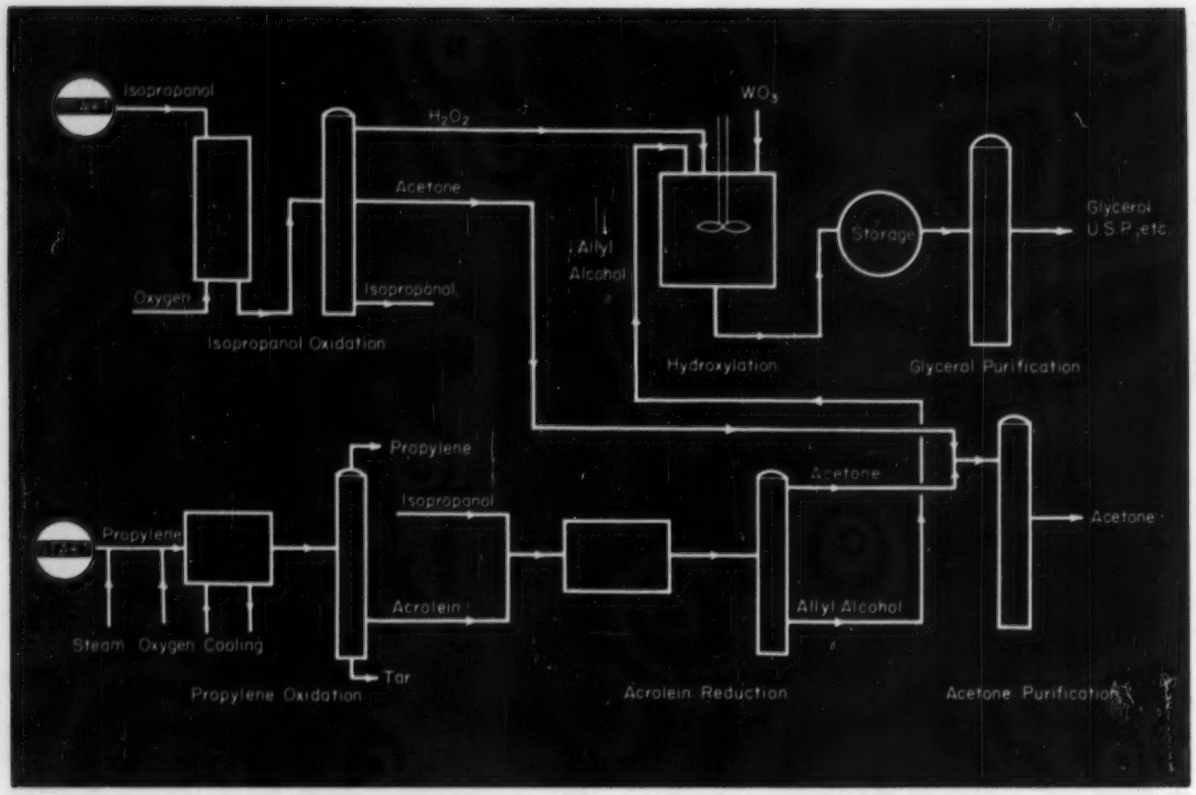
Yields: Over-all process yield, glycerol from propylene and chlorine is 75-80 percent.

Commercial Installation: This process or a variation is used at Shell Chemical Company at Deer Park, Texas. A plant at Norco, La., is planned.

Commercial Installations: The Dow Chemical Company, Freeport, Texas.

References: Miner, C. S. and N. N. Dalton (Eds) Glycerol, *ACS Monograph*, No. 117, '54, pp. 80-83; *Chemical Engineering*, 55, No. 10, Oct. '48, pp. 134-137.


START
Propylene
Propylene Storage
Dryer
Propylene Preheater
Reactor
Cooler
Chlorine
Condenser
Recycle Compressor
Pre-Fractionator
REFLUX
HCl Absorber
WATER
HCl
HCl Scrubber
CAUSTIC
Recycle Propylene
Crude Allyl Chloride
Light Ends
Light Ends Column
Allyl Chloride Column
Heavy Ends
Allyl Chloride Storage
Allyl Chloride
Lime Slurry
Water
Reactor
Separator
Reactor
Hypochlorous Acid Tower
Water
Epichlorohydrin Fractionator
Epichlorohydrin Storage
Epichlorohydrin Stripper
Steam
$CaCl_2$
Heavy Ends
Dilute Caustic
Epichlorohydrin
Reactor
Evaporation
Salt
Evaporation
Vacuum Distillation
Vac
H_2O
Steam
Residue
Finished Glycerol
GLYCEROL



Glycerol (Acrolein and Hydrogen Peroxide)

Application: This is a process for the manufacture of glycerol with large amounts of acetone as a coproduct.

Charge: Propylene, Oxygen.

Description: Propylene is first hydrated to isopropanol using a standard process. (See page 163). The isopropanol is oxidized in the liquid phase by bubbling pure oxygen through a liquid mixture of isopropanol and H_2O_2 at a pressure of about 2.5 atmospheres and at temperatures between 90 and 140 C. The reaction mixture is diluted with water, stabilized, and fractionated to yield hydrogen peroxide solution, acetone and unreacted isopropanol, which can be recycled.

A mixture of propylene with slightly more than an equal amount of steam is reacted with 25 percent oxygen based on the weight of the propylene. The reaction is carried out over a fixed bed of catalyst based on cuprous oxide, supported on SiC or some other high thermal conductivity support. Close control of reaction temperature is necessary. The reaction pressure may be from 1 to 10 atmospheres and the temperature between 300 and 400 C. The reaction mixture is cooled and fractionated to give acrolein, unreacted propylene, and tarry byproducts. The yield of acrolein is near 86 percent of the propylene consumed.

The purified acrolein is mixed with pure isopropanol from the propylene hydration step and the mixture vaporized. The mixed vapors containing 2-3 moles of alcohol per mole of acrolein are passed through a catalyst bed containing both uncalcined magnesium oxide and zinc oxide, with the magnesia predominating. The reaction takes place at about 400 C. and yields about 77 percent allyl alcohol (based on acrolein charged) and an additional quantity of acetone which is added to that formed in the isopropanol oxidation step.

Purified allyl alcohol is agitated with a water solution of hydrogen peroxide containing a small amount of tungsten trioxide in solution. The effective catalyst is a 0.2 percent pertungstic acid solution in 2 molar aqueous hydrogen peroxide. The reaction temperature is 60-70 C., reaction time is about two hours, producing glycerol in water solution.

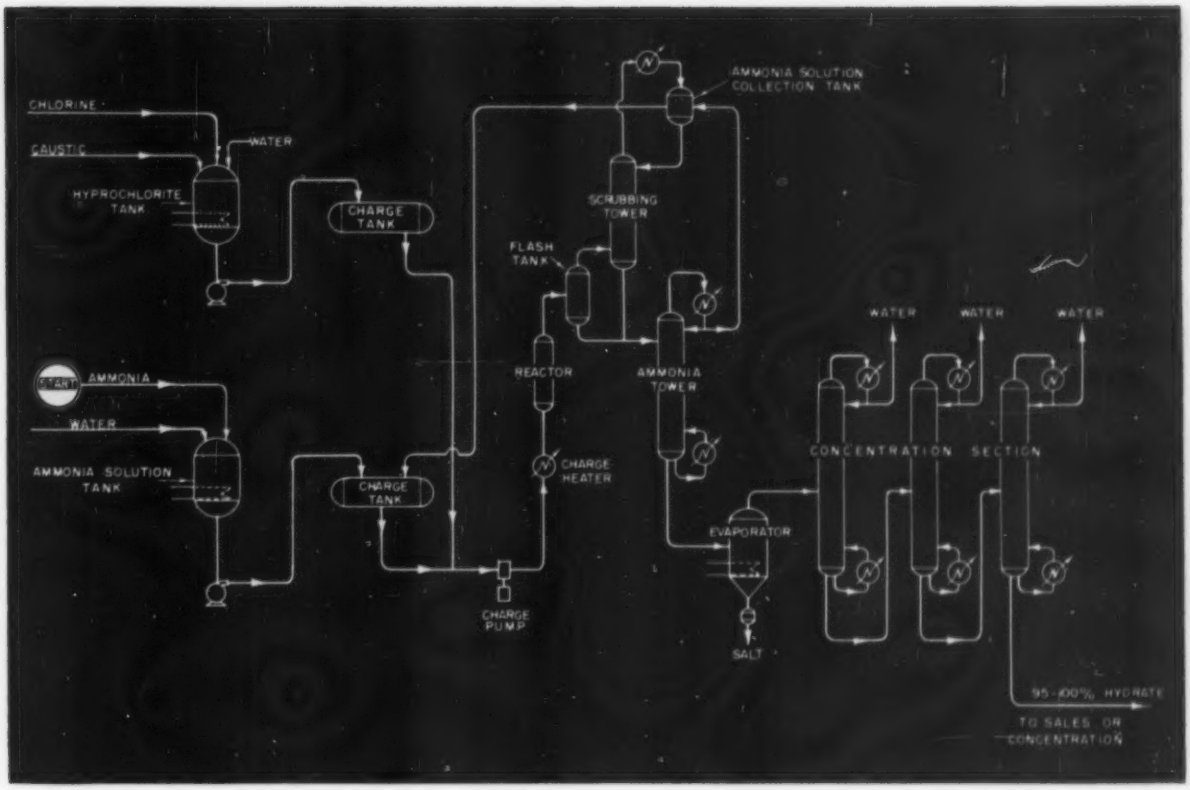
The reaction mixture is dumped to receivers and distilled to yield high-purity glycerol. The recovered catalyst solution is recycled. The yield of the final step is 80-90 percent based on the allyl alcohol charged.

Operating Conditions: The control of both the propylene oxidation step and the hydroxylation step must be exceptionally good for acceptable yields. The conditions quoted are approximate, and the practical operating limits are doubtless much less broad.

Yields: The over-all yield of useful products (glycerol and acetone) is not known. The over-all glycerol yield on propylene charged to the oxidation is in the range of 50-60 percent.

Commercial Installation: This process will be used in a new plant being built in stages by Shell Chemical Company at Norco, La. The hydrogen peroxide and acrolein units were started in the summer of 1955 and the glycerol section is expected to begin operation early in 1956.

References: Glycerol Payoff in Propylene Parlay, *Chemical Week*, May7,'55,p72-77; S. A. Ballard, H. deV. Finch and E. A. Peterson (to N. V. Bataafsche Petroleum Maatschappij), British Patent 619,014, Mar.2,'49; M. Mugdan and D. P. Young, *J. Chem. Soc.*, 49,2988-3000,CA:43-5269h.



Hydrazine

Application: A process for the manufacture of hydrazine.

Charge: Dilute caustic soda (eight percent); chlorine; ammonia.

Product: Hydrazine (N_2H_4); hydrazine hydrate ($N_2H_4 \cdot H_2O$) of 95-100 percent strength.

Description: Chlorine and dilute caustic are mixed to produce an aqueous sodium hypochlorite (NaOCl) solution. About ten percent excess caustic is used. For eight percent caustic the resulting hypochlorite strength is about 70 grams per liter available chlorine.

Anhydrous ammonia is dissolved in purified water to form a 28 weight-percent solution. This material is mixed with a recycle solution of the same strength and placed in a charge tank to be fed to process.

Ammonia and hypochlorite solutions are combined in a molar ratio considerably greater than the 2:1 stoichiometric requirement. Ratios as high as 20-50 NH_3:NaOCl have been used. The mixture is pumped to a pressure of 30 atmospheres, preheated to 320 F., changer, and passed quickly through the tubular reactor.

The successive reactions which occur are:

$$NaOCl + NH_3 \rightarrow NH_2Cl + NaOH$$
$$NH_2Cl + NH_3 \rightarrow N_2N \cdot NH_2 + HCl$$

Conversion of hypochlorite is practically complete. It is necessary to use carefully purified water in the mixing and adjustment of concentration of the reactant solutions, and at the same time employ a purified gelatin inhibitor. With sufficient amounts of this inhibitor the hydrazine yields across the reactor are in the range of 80-90 percent.

The effluent from the reactor contains about 1.5 percent hydrazine in an aqueous solution together with NaCl, NaOH, unconverted ammonia, and minor amounts of side reaction products. The liquid is flashed to a pressure slightly above atmospheric with resulting liberation of ammonia and small amounts of hydrazine. The liquid from the flash chamber is combined with the bottoms stream from the scrubbing tower and fed to an ammonia tower for further ammonia recovery.

The bottoms from the ammonia tower contain the major impurities NaCl (5-6 percent) and NaOH (minor amount). The concentration of hydrazine hydrate ($N_2H_4 \cdot H_2O$) is about three percent. NaCl and NaOH are removed by salting-out in an evaporator. The vapors from the evaporator contain 6-8 percent hydrazine hydrate.

Further concentration of the hydrate is effected in a series of three distillation columns. The concentration becomes in turn 15 percent, 40-45 percent, and 95-100 percent hydrate. The final tower, which produces concentrated hydrate bottoms material, is kept under a nitrogen blanket to minimize explosion dangers.

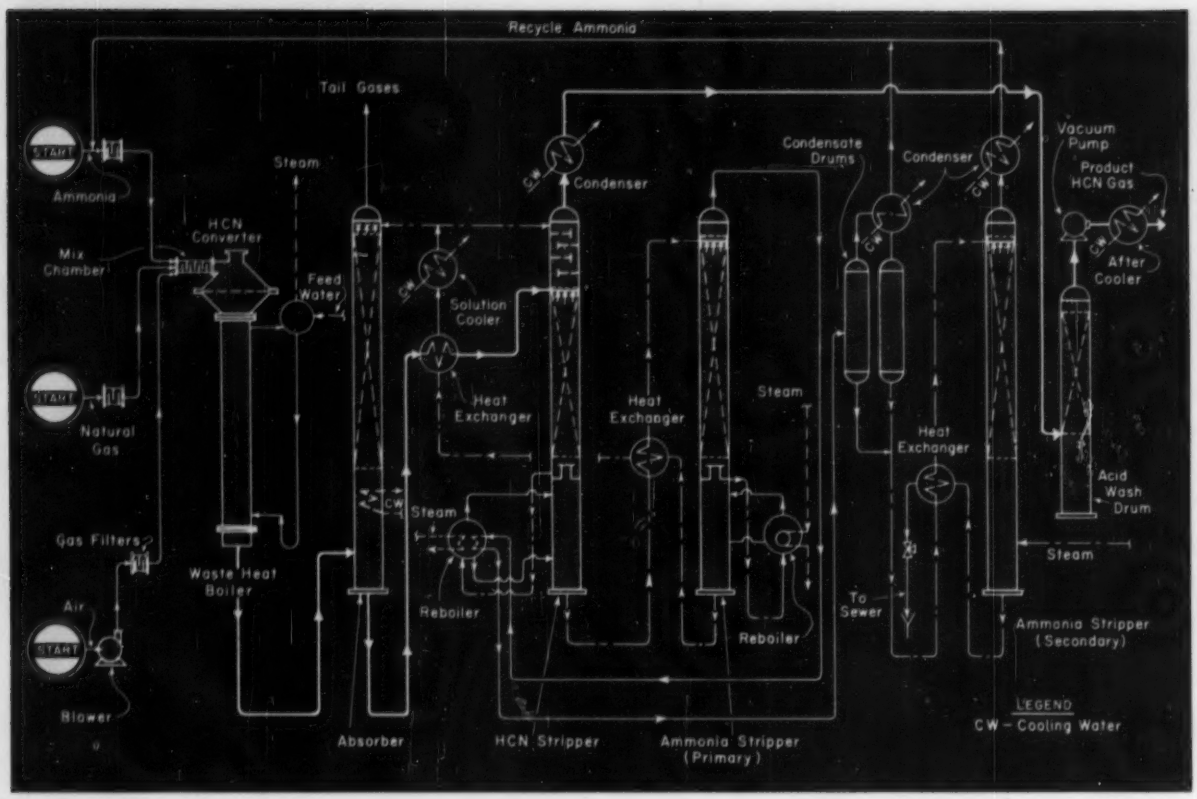
It is not possible to produce anhydrous hydrazine by simple distillation since water and hydrazine form an azeotrope at 58.5 mole percent hydrazine.

Operating Conditions: Given in above text.

Yields: Over-all process yields of 70-75 percent are obtained, based on available chlorine raw material.

Commercial Installations: Mathieson Chemical Corporation at Lake Charles, La.; Fairmount Chemical Company, Newark, N. J.

Reference: Petroleum Refiner, Dec.'54,p166.



Hydrogen Cyanide

THE GIRDLER COMPANY

Application: A process applied to the manufacture of hydrogen cyanide. The reactor gas may also be used to produce alkali cyanides by absorbing hydrogen cyanide in caustic.

Charge: Natural gas and anhydrous ammonia are the charge.

Product: The product is gaseous hydrogen cyanide of 99 percent purity.

Description: Hydrogen cyanide is produced by the reaction of ammonia, natural gas and air over a platinum catalyst which may be represented as follows:

$$NH_3 + CH_4 + 1.5\ O_2 \rightarrow HCN + 3H_2O$$

A unique process developed by Freeport Sulphur Company is employed to separate the hydrogen cyanide from the side reaction gases and to allow the separate recovery of unreacted ammonia.

Ammonia and natural gas, under at least 5 to 10 psig pressure, are filtered and mixed prior to entering the converter vessel. The converter operates at 1800 F. and pressures slightly above atmospheric. The composition of the effluent gas is given below:

Composition of Gas Produced in Generator	Mole Percent
Hydrogen Cyanide	5.9
Ammonia	1.6
Carbon Dioxide	0.2
Carbon Monoxide	4.4
Methane	0.5
Hydrogen	7.5
Oxygen	0.1
Nitrogen	56.7
Water Vapor	23.1
	100.0

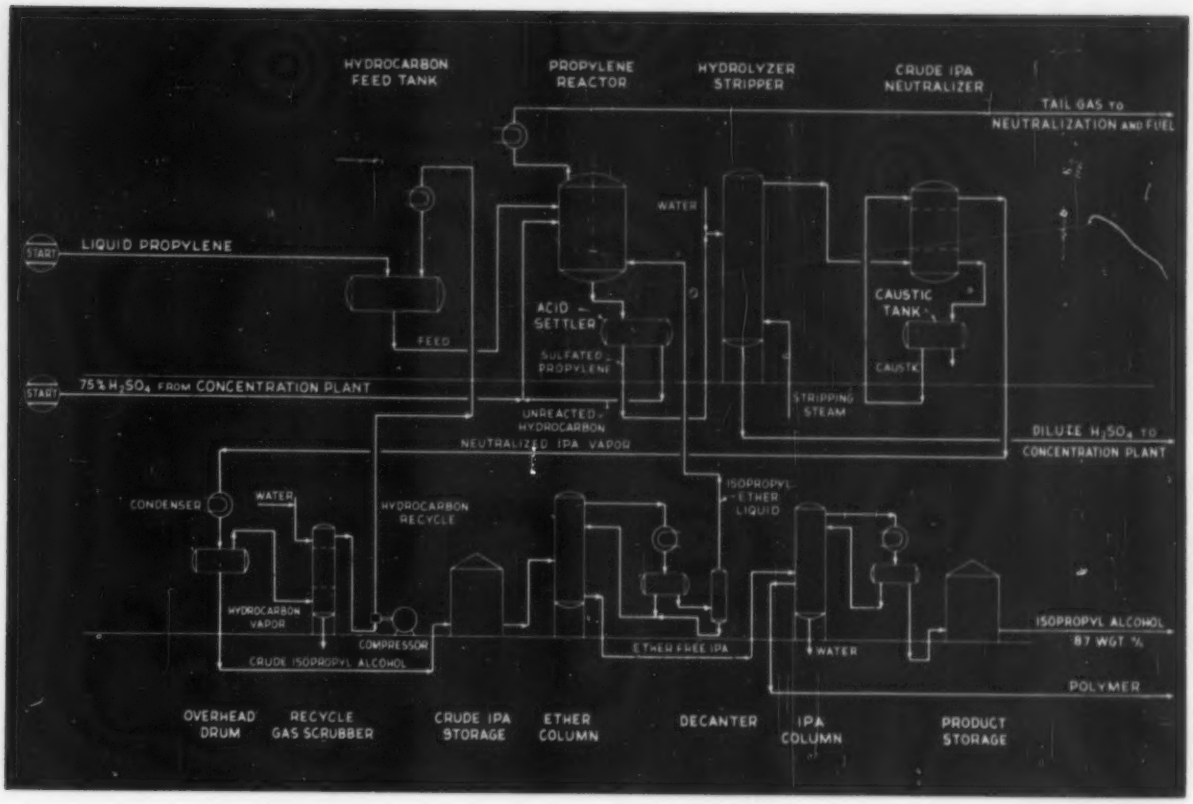
The effluent gases are cooled immediately.

Of the ammonia fed to the converter approximately 67 percent is converted to hydrogen cyanide, 18 percent is dissociated to hydrogen and nitrogen and 15 percent passes through unreacted. As the majority of unreacted ammonia may be recovered and recycled, the over-all ammonia conversion to HCN is about 74 percent.

The separation system is based on the use of a polyhydroxy-boric acid complex. A solution of 8.3 weight percent pentaerythritol and 2.5 weight percent boric acid in water is used. This complex reacts with ammonia in the absorber which prevents polymerization of HCN. The HCN is absorbed by water. HCN is stripped from the absorber bottom stream in the HCN stripper. Residual ammonia is removed from the HCN stream by washing with fresh solvent. The product is then acid washed for final cleanup and delivered at atmospheric pressure. The HCN-free solution goes to the primary ammonia stripper where the polyhydroxy-boric acid complex dissociates and releases ammonia. The stripper operates at 25 psig pressure and 270 F. Some ammonia gas is liberated here, cooled and recycled to the HCN converter. The condensate from this gas stream is steam stripped in the secondary ammonia stripper where the bulk of the ammonia is recovered and recycled.

Yields: Approximately 74 percent of ammonia charged is converted to hydrogen cyanide.

Commercial Installations: The process has been developed through the pilot plant stage by Freeport Sulphur Company.



Isopropyl Alcohol

STONE & WEBSTER-BADGER

Application: A process for manufacturing isopropyl alcohol.

Charge: Liquid propylene. A feed of 90 percent purity or better is desirable to minimize the handling of waste gas, although much lower concentrations of propylene can be handled satisfactorily.

Product: The product is a solution of 87 weight percent isopropyl alcohol.

Description: The liquid propylene feed stock, combined with recycled hydrocarbons, is first absorbed in 75 percent sulfuric acid in a series of agitated reactors to form a solution of diisopropyl sulfate and isopropyl acid sulfate. The sulfated hydrocarbon solution is converted to an acid solution of isopropyl alcohol, ether and polymer by hydrolysis reactions which take place in the hydrolyzer-stripper in the presence of dilution water. These reaction products are steam stripped from the acid in the same column and leave as overhead vapors. The vapors are neutralized by contact with caustic solution and then condensed. The condensate is sent to an ether column for ether separation.

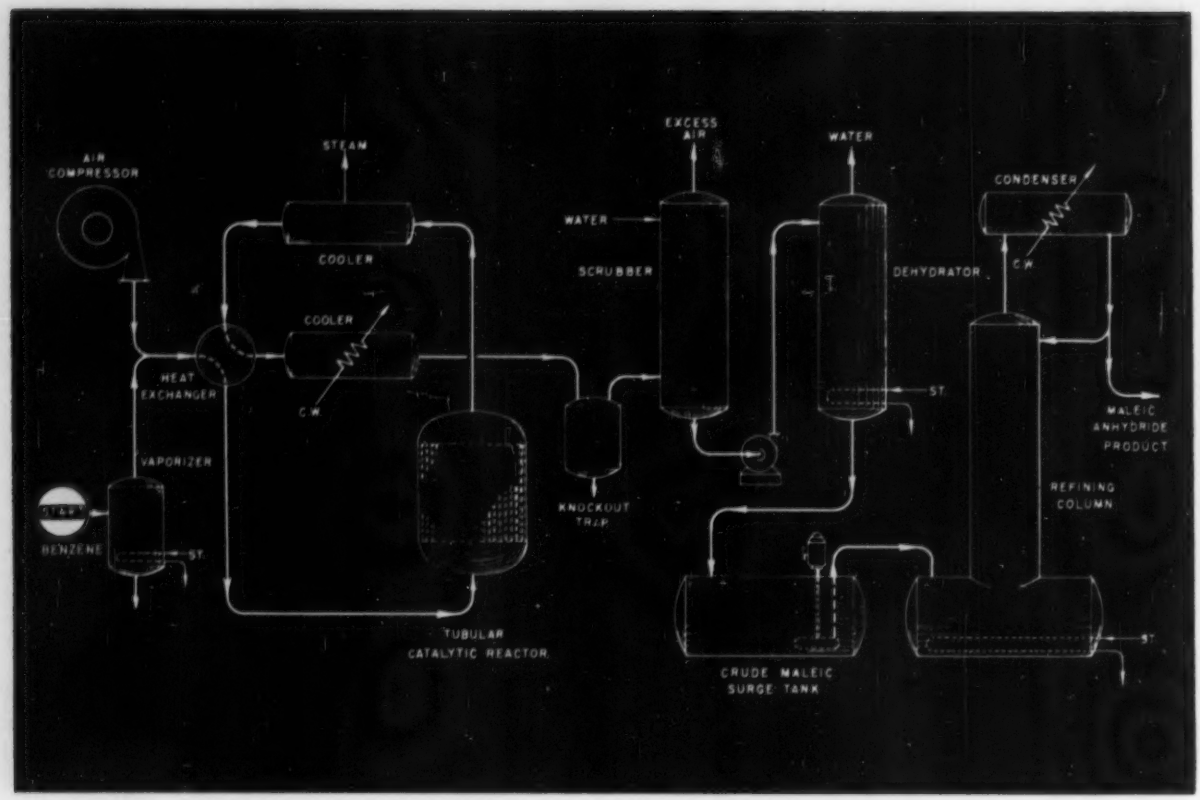
The crude isopropyl alcohol is charged to the ether column. The bulk of overhead vapors from this column is condensed and refluxed to the column. A portion of the liquid is diverted from the main reflux stream and sent to a decanter for separation. In the decanter the two liquid layers are separated and the upper layer, very rich in ether, and the lower layer contains mainly water and small amounts of ether and alcohol. The lower water-rich layer is refluxed back to the tower continuously along with the main reflux stream going to the column. The ether-rich layer is pumped back into the reaction system.

The liquid containing the bulk of the isopropyl alcohol, polymer and water, is pumped to the isopropyl alcohol column for recovery of the main product. The condensed overhead from this column is the 87 percent solution of isopropyl alcohol in water. Polymer is withdrawn as a side stream from the column and pumped to storage. From the base of the isopropyl alcohol column, water is withdrawn containing only traces of alcohol. This water is reused in the hydrolyzer-stripper.

Operating Conditions: The propylene sulfation occurs in the reactors at 300-400 psig. All other equipment, except for the propylene feed tank, operates at near atmospheric pressures. No mechanical refrigeration is required.

Yields: Ninety-five percent of propylene charge is converted to isopropyl alcohol.

Commercial Installations: This process is based on development work carried out by the Distillers Company, Ltd., with recent improvements by Stone and Webster. A large commercial plant has been in operation for more than a year in the United Kingdom.



Maleic Anhydride

SCIENTIFIC DESIGN COMPANY, INC.

Application: A process for the manufacture of maleic anhydride.

Charge: Benzene, nitration grade.

Product: Maleic anhydride, pellets.

Description: Benzene is vaporized in kettles and fed to a vessel for mixing with air. The mixed gases are preheated and passed to a multitubular, cooled catalytic reactor.

The reactor effluent gases pass through three coolers in sequence. The first cooler generates steam. The second is a recuperative exchanger which serves to preheat feed gas. The third cooler uses cooling water. Tarry condensates are removed by a knockout trap. The reactor effluent gases then pass to a water scrubber where maleic anhydride is absorbed. The maleic acid solution is pumped to a dehydrator which regenerates maleic anhydride. Only a minimum of maleic is transformed to isomeric fumaric acid in the dehydration step, by careful control of conditions. The crude maleic anhydride is purified in a refining column. The product cut is pelletized and bagged in conventional machines.

Tempered cooling water is used to prevent plugging of the reactor aftercooler by solid maleic anhydride. A startup heater (not shown on this schematic flow diagram) serves to bring the feed airstream up to reaction temperature. This preheater burns natural gas or other cheap fuel.

Several oxidations take place simultaneously in the reactor; the two most important reactions are represented as follows:

$$(1)\ C_6H_6 + 4\tfrac{1}{2}O_2 \rightarrow C_4H_2O_3 + 2H_2O + 2CO_2$$
$$(2)\ C_6H_6 + 7\tfrac{1}{2}O_2 \rightarrow 6CO_2 + 3H_2O$$

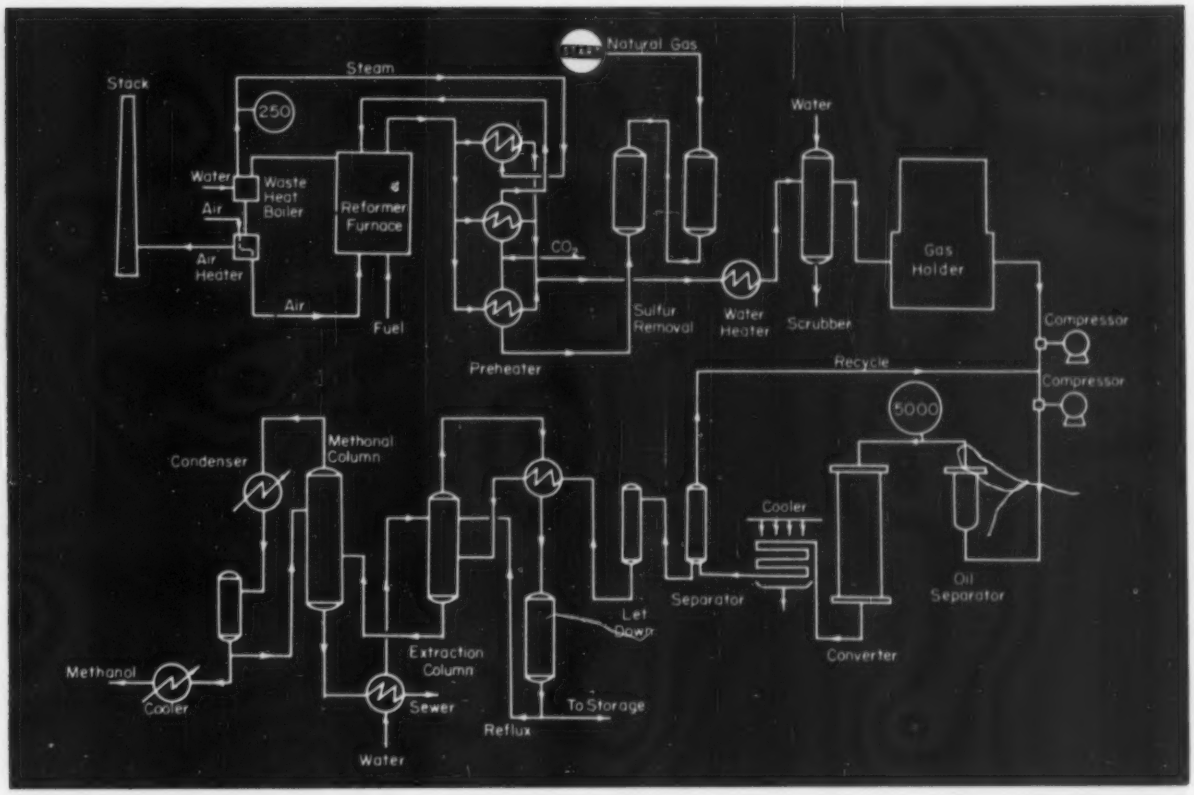
Operating Conditions: The most important operating variables are the benzene concentration in the reactor inlet gases, the temperature in the reactor, and the contact time. Typical operating ranges for these variables are given below:

Benzene concentration: 0.6-1.6 percent by volume
Reaction temperature: 700-850 F.
Contact time: 0.1-2.0 seconds

Yields: The over-all yield is usually expressed as pounds of maleic anhydride per pound of benzene. Yields of over 70 percent have been observed in pilot plant operation. Under certain conditions of feed and product prices a plant may be designed to show yields of over 80 weight percent.

Commercial Installations: A maleic anhydride plant using this process is now under construction for Compagnie Francaise des Matieres Colorantes at Villers-St. Paul, France. A reaction system using the Scientific Design Company catalyst has been in commercial operation at Reichold Chemicals Elizabeth, N. J., plant for approximately one year.

Reference: *Chemical Engineering*, July'53,p.238.



Methanol

COMMERCIAL SOLVENTS CORPORATION

Application: A process for the manufacture of methanol.

Charge: Natural gas.

Product: Methanol.

Description: The first step in the process is the removal of organic sulfur and hydrogen sulfide from the natural gas feed stock. This is accomplished in the sulfur removal vessels by contacting the gas with activated carbon.

The purified gas is pre-heated by exchange with reformer products, mixed with carbon dioxide and superheated steam and passed downward in the reformers. The reformers are heated with fuel gas and the flue gas is used to generate 250 psi steam and to heat the primary combustion air for the reformer heater burners. The reformer product stream is further cooled in the feed water heater and then water quenched before going to a gas holder.

The cooled reformed gas from the gas holder is compressed to 5000 psig by the primary compressors and the circulating compressors. This high pressure gas stream flows to oil traps for the removal of entrained oil before being introduced to the converters. The outlet from the oil trap vessel and filter is divided into three (3) streams. The main stream goes to the converter top and a small by-pass stream sent to the bottom of the converter for quench while a small stream is sent to the quench lines at the top of the reactor. The converter effluent is cooled in a spray cooler and flows to a separator. The unconverted gases from the separator are recycled to an intermediate stage of the primary compressors and the condensed product from the separator flows to the low-pressure letdown and separator drum. The liquid product from the letdown drum flows to crude methanol storage.

The impurities present in the crude methanol (isopropyl and isobutyl alcohol, traces of ethers, ketones and aldehydes) have boiling points near that of methanol itself and present a real problem in the purification of methanol. The extractive distillation method is used by Commercial Solvents Corporation.

The crude methanol is preheated in the extraction column condensers and fed to the extraction column. The heads from this column are partially used for reflux and the remainder cooled and sent to intermediate storage. Soft water, heated by exchange with the methanol column bottoms, is introduced as extract in the extraction column. The bottoms from the extraction column are fed to the methanol column where the overhead is finished methanol product. A portion of this overhead is used for reflux on the methanol column. The bottoms are sent to sewer. A bottom fraction is removed from the methanol column and goes to the tails column for the recovery of higher alcohols.

Operating Conditions: The converter operates at 5000 psig and 400 C. with about 12 to 15 percent conversion of feed gas to methanol per pass.

Commercial Installation: Commercial Solvents Corporation, Sterlington, La.

Reference: *Chemical Engineering*, June'55.

Methanol

THE VULCAN COPPER & SUPPLY COMPANY

Application: This process is applied to the manufacure of methanol.

Charge: Synthesis make-up gas (carbon monoxide and hydrogen) derived from natural gas, coal, by-product gases or oil is the charge.

Product: The product is high purity methanol.

Description: Synthesis make-up gas, supplied at a pressure of 5000 psig is passed through the iron carbonyl guard chamber for removal of iron carbonyl in the gas stream. Activated carbon is the absorbing reagent used. The synthesis make-up gas enters the synthesis system via an oil trap. Here, the compressed make-up gas joins the recycling gases of the synthesis system and traces of lubricating oil in the gases from the recirculator are removed. The collected oil is let down intermittently from the oil trap, as necessary, to an oil recovery system.

The combined gases, leaving the oil trap enter the converter at ambient temperature. In the converter, the active gas constituents, equivalent to the amount in the synthesis make-up gas, are converted to methanol, water and side-reaction products in vapor form, at approximately 640-680 F. However, due to internal heat exchange apparatus provided in the converter, the gases leave the converter at about 290 F.

The reactions involved are rather simple and are shown by the following equations:

$$CO + 2H_2 \rightarrow CH_3OH \quad (1)$$

$$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O \quad (2)$$

The first reaction is preferred as it requires less hydrogen.

The effluent gases from the converter pass through the water-cooled primary condenser and the refrigerated secondary condenser where essentially 100 percent of the reaction products are condensed. The liquid product is separated from the gas stream in the methanol separator, the gases from the separator passing on to the suction of the recirculator which compresses the recycle gases sufficiently to overcome the system pressure drop and injects the recompressed gases into the oil trap.

Between the methanol separator and the recirculator a very small portion of the recycle gas stream may be vented to maintain the partial pressure of the non-reactive gases in the recycle gas stream at a reasonable level.

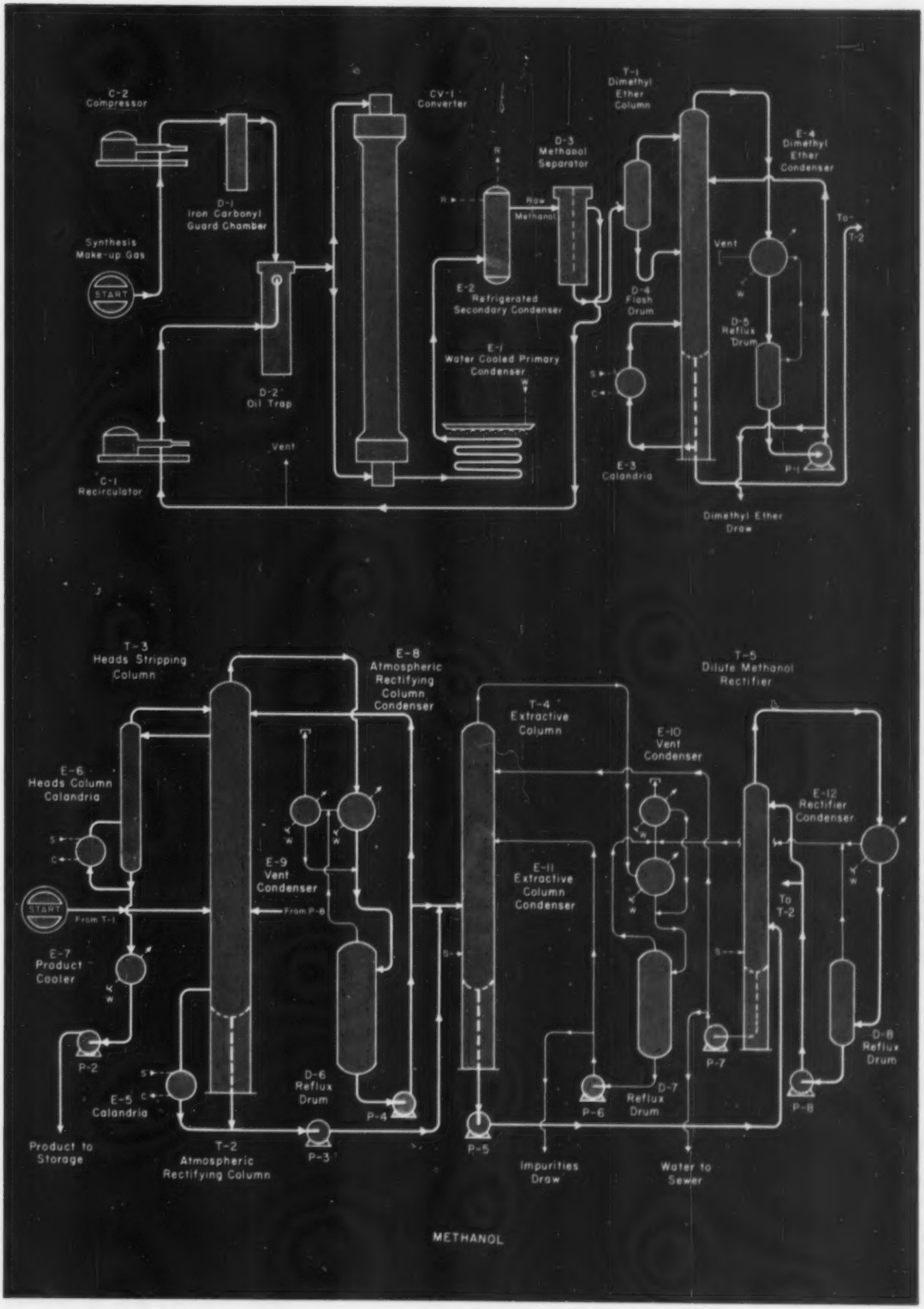
The raw methanol product, separated from the gases in the separator, is continuously let down to the low pressure flash drum where the bulk of the dissolved gases and low boiling compounds are vented due to the reduction in pressure. The condensate is fed into the dimethyl ether column, which operates under pressure, for removal and concentration of the remaining low boiling compounds. The steam-heated calandria supplies the necessary heat for the pressure stripping operation to remove the low boilers. The low boiling compounds are taken overhead and the water-cooled dimethyl condenser condenses the dimethyl ether, the non-condensables being vented from the system. The resultant dimethyl ether product is collected in the reflux drum. Part of the dimethyl ether column as reflux and part is drawn off to dimethyl ether product storage.

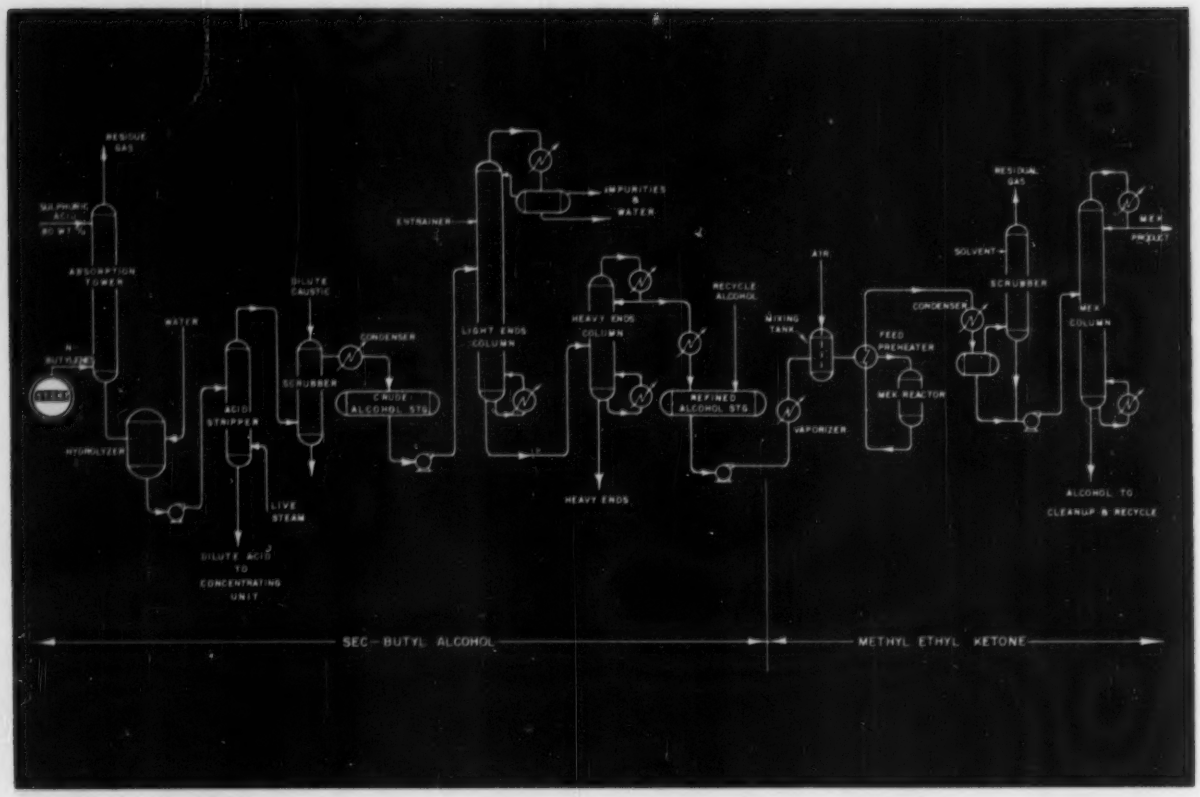
Crude methanol is drawn off as bottoms from the dimethyl ether column and fed to the atmospheric rectifying column. Steam-heated calandria provide the necessary heat for rectification. A liquid methanol draw is taken near the top of the rectifying column and sent to the heads stripping column for final removal of traces of low boilers, the steam-heated heads column calandria providing the necessary heat for stripping the low boilers. Refined methanol is taken as bottoms product from the heads stripping column, cooled in the product cooler and transferred to finished product storage.

The low boilers, which are concentrated in the top of the rectifying column are taken overhead with an appreciable amount of methanol and are condensed in the atmospheric rectifying condenser and the vent condenser, the non-condensables being vented and the condensate collected in the reflux drum. Part of the condensate from the reflux drum is sent to the rectifying column as reflux, and part is sent to the extractive distillation column for recovery of methanol and concentration of impurities. Also, a bottoms fraction from the atmospheric rectifying column is transferred to the extractive distillation column for recovery of methanol and concentration of high boilers.

The extractive distillation column is heated by live steam injection and refluxed with water. Concentrated impurities are taken overhead and condensed in the extractive distillation column condenser and vent condenser, the non-condensables being vented from the system. The resultant condensate is collected in a reflux drum. Part of the condensate is recycled to the extractive distillation column and part is withdrawn from the system. Dilute methanol is withdrawn from the base of the extractive distillation column and transferred to the dilute methanol rectifier where concentrated methanol is taken overhead and condensed in the rectifier condenser. The concentrated methanol condensate is collected in the reflux drum. Part of the condensate is used as reflux and part is returned to the atmospheric rectifying column to recover the methanol content. Non-condensables are vented from the dilute rectifier condenser and the reflux drum through the vent condenser for recovery of trace quantities of methanol.

Operating Conditions: The most important operating conditions are those in the reactor. The operating pressure in the reactor is about 4200 psig, and the temperature is 520-620 F.


C-2 Compressor
CV-1 Converter
T-1 Dimethyl Ether Column
D-3 Methanol Separator
E-4 Dimethyl Ether Condenser
D-1 Iron Carbonyl Guard Chamber
Raw Methanol
To T-2
Synthesis Make-up Gas
START
Vent
E-2 Refrigerated Secondary Condenser
D-4 Flash Drum
D-5 Reflux Drum
E-1 Water Cooled Primary Condenser
D-2 Oil Trap
E-3 Calandria
C-1 Recirculator
Dimethyl Ether Draw
T-3 Heads Stripping Column
E-8 Atmospheric Rectifying Column Condenser
T-5 Dilute Methanol Rectifier
T-4 Extractive Column
E-10 Vent Condenser
E-6 Heads Column Calandria
E-12 Rectifier Condenser
E-9 Vent Condenser
From P-8
E-11 Extractive Column Condenser
To T-2
E-7 Product Cooler
P-2
P-7
D-8 Reflux Drum
D-6 Reflux Drum
P-4
P-6
D-7 Reflux Drum
P-8
E-5 Calandria
P-3
P-5
Product to Storage
T-2 Atmospheric Rectifying Column
Impurities Draw
Water to Sewer
METHANOL



Methyl Ethyl Ketone and Acetone

Application: This process is for the manufacture of methyl ethyl ketone (MEK).

Charge: A mixture of normal butylenes.

Product: The product is methyl ethyl ketone (99 percent purity).

Description: Gaseous butylenes are charged to the absorption tower which operates at pressures slightly above atmospheric and at a temperature of 110 F. Sulfuric acid (about 80 percent) is fed to the top of the tower and reacts with the butylenes to form butyl sulfates. The reaction is exothermic, and internal cooling is provided.

Conversion of butylenes is practically complete. The mixture of acid and butyl sulfates flows to hydrolyzer where alcohols are formed from the sulfates. *Sec*-butyl alcohol is the principal product.

The hydrolyzate is fed to the acid stripper and alcohols are steam stripped from the acid. Entrained acids in the alcohol stream are removed in a dilute (8-10 percent) caustic scrubber. The scrubbed vapors are condensed. The crude contains 10-20 percent water, light organics, *sec*-butyl alcohol and heavier organics.

The major problem in the purification is the separation of the *sec*-butyl alcohol from water. This is done in a tower to which an entrainer material, such as diisobutylene, is added. The entrainer forms light-boiling ternary azeotropes with the impurities and water. These azeotropes are taken overhead. *Sec*-butyl alcohol is separated from the heavy ends in the heavy ends column.

The *sec*-butyl alcohol is vaporized and fed to a mixing tank where it is combined with a small amount of air. The mixture, at 250-300 F., is heated to 750 F. and fed to the reactor.

The reactor contains a number of small-diameter tubes packed with supported zinc oxide catalyst. The reaction is exothermic, maximum temperature about 1000 F., with a combined oxidation-dehydrogenation of the alcohol to MEK.

The reactor effluent contains MEK, unconverted alcohol, hydrogen and other fixed gases. The mixture passes through a preheater and a brine-cooled condenser. Equilibrium amounts of MEK and alcohol remaining in the vapor are recovered in a separate column by absorption in a non-volatile solvent.

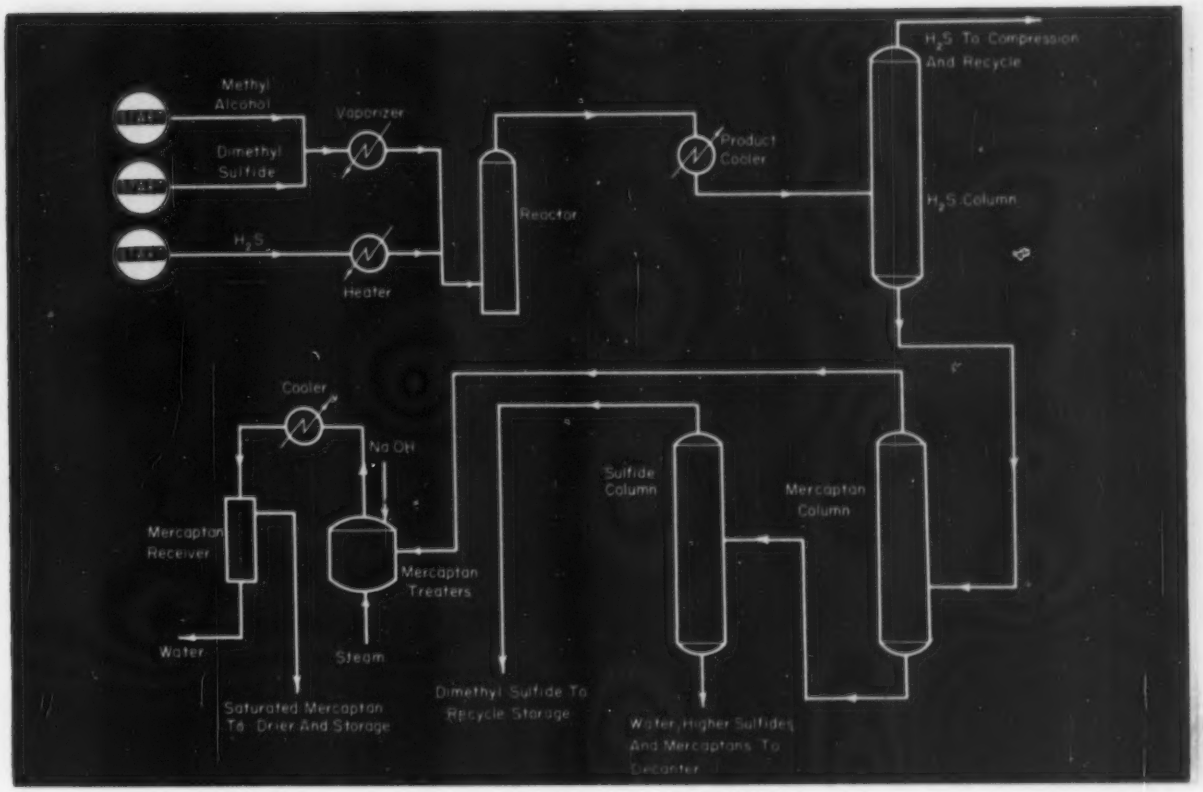
The combined liquid streams from condenser and scrubber are fed to a fractionator where MEK with a minimum purity of 99.0 weight percent is removed overhead.

Acetone is made primarily from isopropyl alcohol by a similar combined oxidation-dehydrogenation reaction such as described above.

Yields: Over-all process yield, MEK from butylene, is 75-80 percent.

Commercial Installations: This process or a variation is used for making MEK at the following plants: Esso Standard Oil Company, Linden, N. J.; Shell Chemical Company, Deer Park, Texas, Martinez, Calif. and Dominguez, Calif.; Stanolind Oil Gas Company, Brownsville, Texas.

Reference: Petroleum Refiner, Feb.'54,p141.



Methyl Mercaptan

Application: A process for the manufacture of methyl mercaptan from its alcohol.

Charge: Raw materials to this process are methyl alcohol, hydrogen sulfide and recycle dimethyl sulfide.

Products: Methyl mercaptan, dimethyl sulfide and higher sulfides.

Description: Alcohol and recycle dimethyl sulfide are vaporized and are mixed with a heated, compressed H_2S stream before entering the fixed bed reactor. Effluent from the reactor is partially condensed and then flows to a primary column, where excess H_2S is removed by distillation. The overhead from this column is refrigerated.

Bottoms from the H_2S column, essentially H_2S free, is fed to the mercaptan column where methyl mercaptan is removed overhead. Water, dimethyl sulfide and higher sulfides, which are the bottoms from the mercaptan column, are fractionated in the sulfide column where dimethyl sulfide is taken overhead. Water and heavier sulfides flow to a cooler-decanter where water of reaction is removed and higher sulfides are recovered if desired.

The mercaptan recovered in the second column of the fractionation train contains small quantities of H_2S which must be removed if the mercaptan is to be used in certain types of subsequent processing. This can be done in a batch treater where the mercaptan is dissolved in a 20% NaOH solution. The hydrogen sulfide is converted to the sodium salt. The mercaptan reacts with the sodium hydroxide to form a thermally unstable salt. Heating reverses this reaction and liberates the mercaptan from solution. Residual traces of mercaptan in the caustic can be recovered by steam stripping. Mercaptan recovered in the stream stripping step is decanted and the total product is dried. For large scale production this operation can be made continuous.

Methyl mercaptan is synthesized from the alcohol by the following reaction:

$$CH_3OH + H_2S \rightarrow CH_3SH + H_2O$$

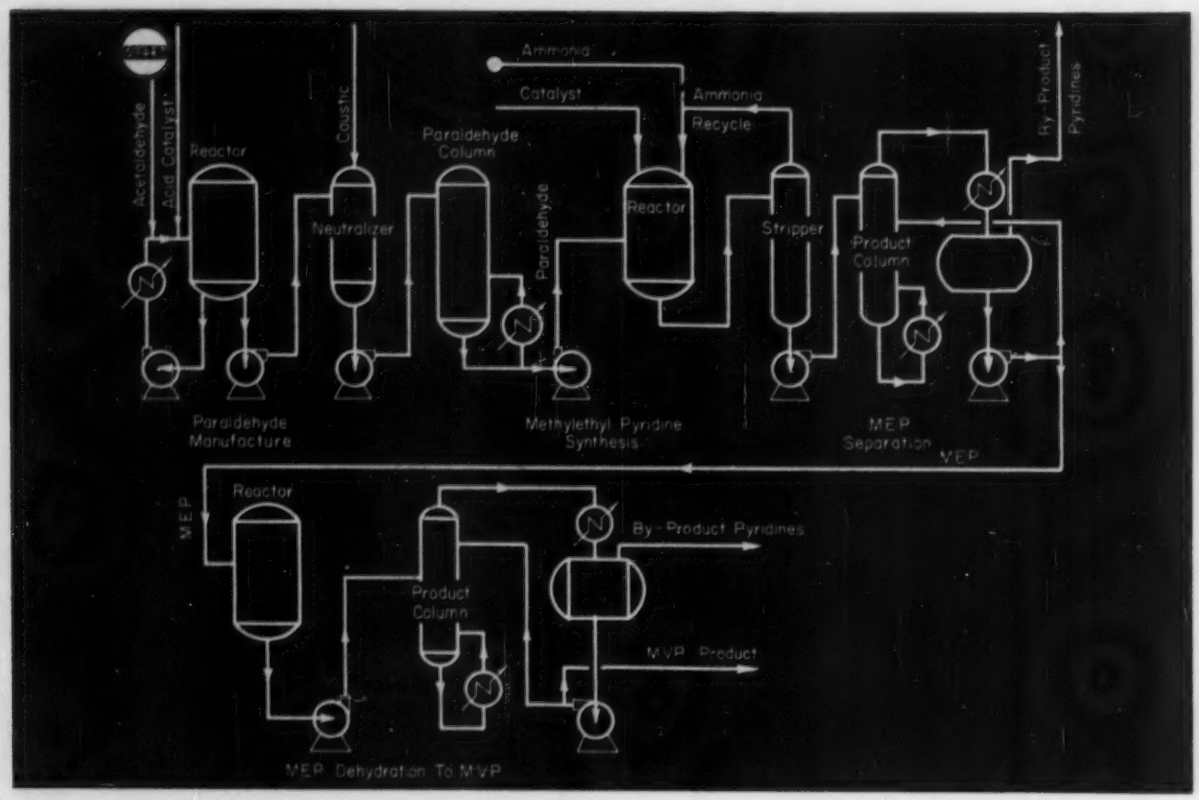
The secondary reaction which takes place is:

$$2\ CH_3SH \rightleftarrows (CH_3)_2S + H_2S$$

An excess of H_2S tends to minimize the extent of this reaction and recycle sulfide is converted to mercaptan by this means.

Several catalysts have been used for this reaction. Among these are 5 percent thoria in alumina, silica alumina, high density 12 percent thoria in alumina, thoria-cobalt. A pellet size of ⅛ inch has proven satisfactory. The H_2S ratio can be varied from 3:1 to 8:1 with respect to total methyl radical input depending on the amount of sulfide recycled. Reactor temperatures vary from 600-875° F depending on feed and catalyst with a pressure of 125-225 psia proving satisfactory.

Handling H_2S introduces special problems in materials of construction in this system, where water of reaction is present.



Methyl Vinyl Pyridine

Application: This process is for the manufacture of methyl vinyl pyridine.

Charge: Acetaldehyde and ammonia.

Product: The product of methyl vinyl pyridine.

Description: The first step in the synthesis is to convert acetaldehyde into paraldehyde. This is done by trimerization of three moles of acetaldehyde to one mole of paraldehyde in the presence of sulfuric acid and catalyst.

$$3\,CH_3CHO \xrightarrow[\text{Catalyst}]{H_2SO_4} (CH_3CHO)_3$$

This polymerization is continuous with make-up acetaldehyde and sulfuric acid being fed continuously to the reactor. An external heat exchanger is used to remove the heat of reaction. Before purification by fractionation of the paraldehyde for the Methyl Ethyl Pyridine (MEP) synthesis the acid is neutralized by addition of caustic.

The liquid phase reaction of paraldehyde with ammonia proceeds as follows:

$$1\tfrac{1}{3}\,(CH_3CHO)_3 + NH_3 \rightarrow \text{C}_5\text{H}_3\text{N}(C_2H_5)(CH_3) + 4\,H_2O$$

Along with MEP a certain amount of 2-picoline, 4-picoline and heavy pyridines are formed. Ammonia in excess of theoretical requirements is used.

Crude product is next sent to the separation section and the various pyridine recovered as technical grades. Excess ammonia is recycled and certain fractions sent back for rerun. MEP fraction is transferred to intermediate storage before going to the Methyl Vinyl Pyridine (MVP) synthesis section.

MEP is recovered as a clear liquid of 345-356 F. boiling range at atmospheric pressure. MEP has other end uses than the manufacturing of MVP.

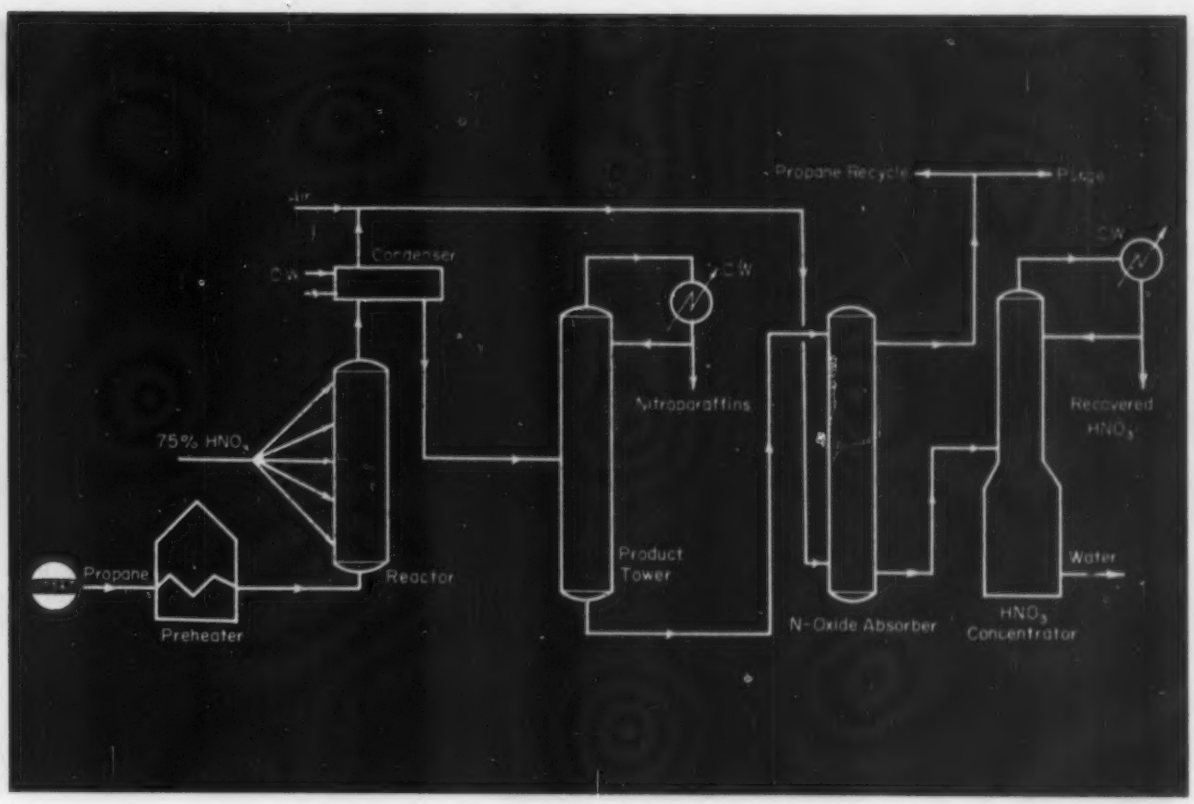
MEP dehydrogenation to Methyl Vinyl Pyridine proceeds as follows:

$$CH_2-CH(H)-\text{C}_5\text{H}_3\text{N}-CH_3 \xrightarrow{\text{Catalyst}} CH_2=CH-\text{C}_5\text{H}_3\text{N}-CH_3 + H_2$$

Along with the main product MVP (2-methyl-5-vinyl pyridine) certain by-products are also produced as in the methyl ethyl pyridine synthesis. MVP is recovered as a final product.

Commercial Installations: A plant using a process similar to this is operated by Phillips Chemical Company, Adams, Terminal, Houston.

Reference: *Petroleum Processing*, Dec.1952, p1802.



Nitroparaffins

Application: A process for the manufacture of nitroparaffins from propane.

Charge: Propane and 75 percent nitric acid.

Products: Nitromethane, nitroethane, 1-nitropropane, and 2-nitropropane.

Description: Propane gas is heated to 430-450 C. in a furnace and enters a glass or silica-lined reactor. The 75 percent nitric acid is sprayed into the gas stream at several points. The amount of acid from each spray is adjusted so that the heat of vaporization of the water in the acid counteracts the exothermic heat of the reaction to maintain the temperature at 390-440 C. The over-all mole ratio of propane: nitric acid is 5:1, with the stagewise addition limiting the ratio at any one stage to 25:1.

It is important that pyrolytic temperatures be avoided in order to prevent carbon skeleton rearrangements. At the proper nitration temperatures some decomposition of the various nitrated and oxidized compounds does occur and therefore some olefins and degraded products are formed. The pyrolysis of nitroethane and 1-nitropropane gives olefins, aldehydes, carbon dioxide, and nitrogen.

Nitric acid and nitrogen dioxide give the same products, but nitric acid gives better yields and higher nitration rates. Comparison of various reaction rate studies shows that the substitution of any hydrogen atom can be effected more readily by nitric acid than by nitrogen dioxide. Some experimental runs show four times the yield using nitric acid rather than nitrogen dioxide.

The gas leaving the reactor is cooled in a partial condenser. The nitroparaffins and dilute nitric acid are condensed while propane and gaseous oxidation products pass to recovery units from which recovered propane is recycled. The condensate separates into two layers. The lower dilute nitric acid layer is fed back to the nitrator as makeup, after fortification with fresh nitric acid. The upper nitroparaffin layer is fractionated into the four products of the reaction.

Under the conditions of the reaction the products obtained will represent all possible ones in which the nitro group replaces either a hydrogen or any alkyl group in the hydrocarbon feed. Close control of the reaction is necessary to avoid excessive losses by oxidation.

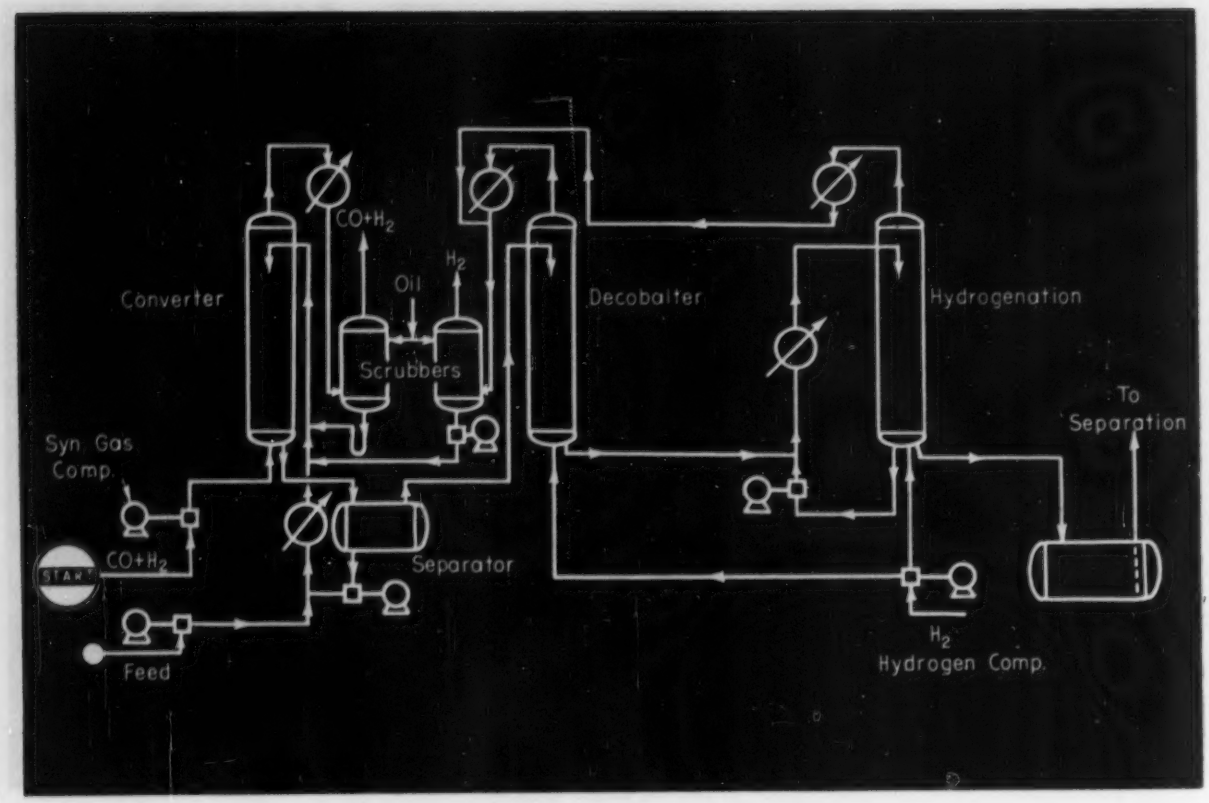
Yields: Yields of 40 percent per pass based on nitric acid conversion to nitroparaffin are reported.

EFFECT OF TEMPERATURE ON PRODUCTS NITRATING PROPANE

PRODUCT	500-510 C. Mole %	790-800 C. Mole %
Nitromethane	22.0	32.2
Nitroethane	16.6	24.2
1-nitropropane	13.2	24.2
2-nitropropane	48.2	19.3

Commercial Installation: This process is in commercial use by Commercial Solvents Corporation at Peoria, Ill.

References: Hass and Schechter, *Industrial and Engineering Chemistry*, 39,p817 (1947). P. H. Groggins (Ed.), *Unit Processes in Organic Syntheses*, 4th Edition, pp2-14 and 77-79. New York, McGraw-Hill Publishing Co., 1952.



OXO Process

Application: A process for the hydroformylation of olefins.

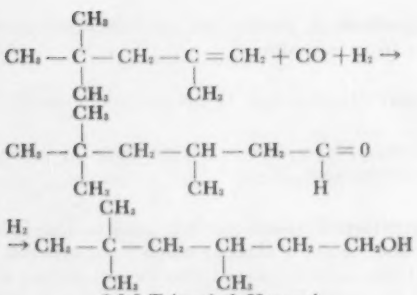
Charge: Carbon monoxide, hydrogen and an olefin.

Product: An aldehyde containing one more carbon atom than the hydrocarbon feed stock.

Description: The synthesis gas (carbon monoxide and hydrogen) is compressed to converter pressure (100-250 atmospheres) and introduced to the bottom of the converter. At the same time the olefin feed is introduced into the top of the converter. The overhead is cooled and scrubbed for recovery of carbonyl product and returned to the converter. The synthesis gas is recycled. The bottoms from the converter is separated with the light product going to the decobalter and the heavy product being recycled to the converter. The overhead from the decobalter is cooled and scrubbed for recovery of carbonyl product and re-introduced as feed to the converter. Hydrogen is introduced in the bottom of the decobalter and is recycled from the overhead scrubber. This decobalted product is fed to the top of the hydrogenation vessel. The overhead product from the hydrogenation vessel is cooled and scrubbed and returned as feed to the converter. The hydrogen from the scrubber is recycled. Hydrogen is introduced into the bottom of the hydrogenation vessel to convert the Oxo aldehydes into the corresponding alcohols.

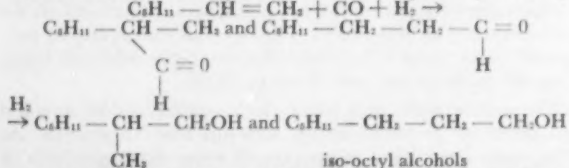
Reactions: Typical reactions using the Oxo process are as follows:

Production of Trimethyl hexanol from di-isobutylene



3,5,5-Trimethyl Hexanol

Production of iso-octyl alcohol from Heptene (mixture)

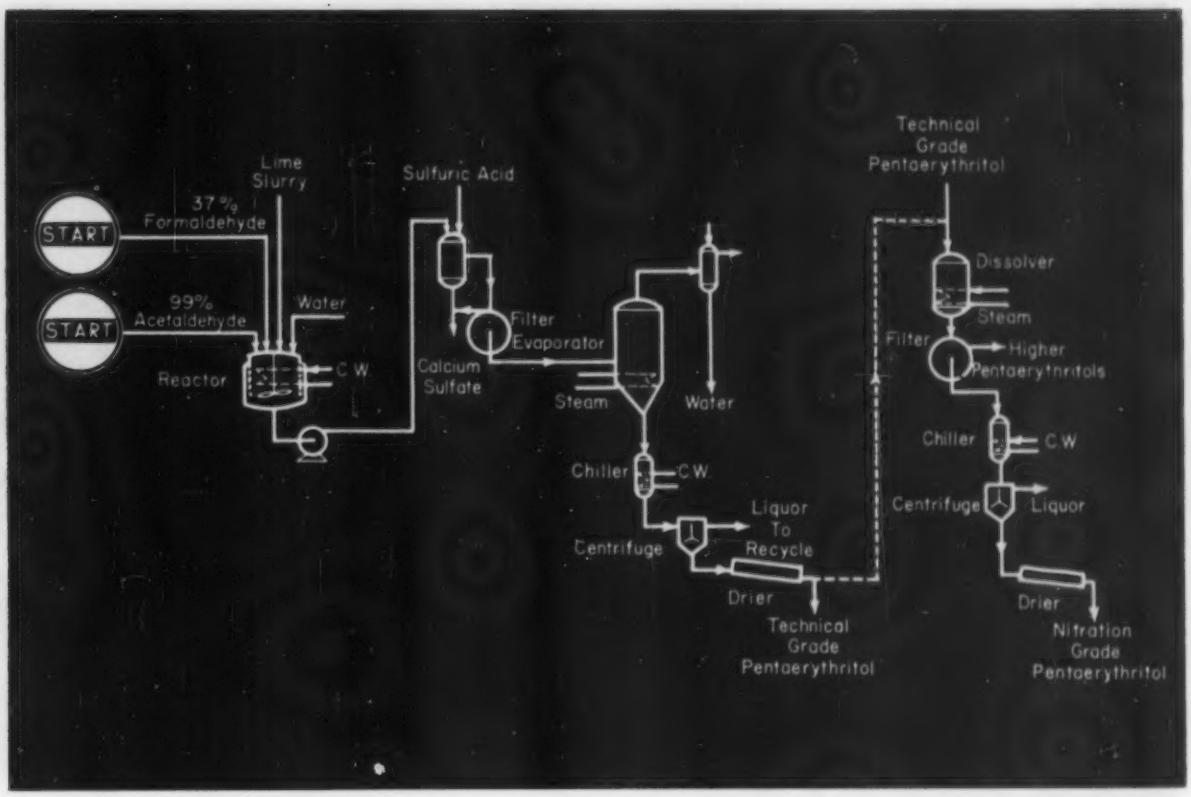


iso-octyl alcohols

Operating Conditions: Synthesis gas having a volume ratio of 1:1 for carbon dioxide and hydrogen. Temperature range of 120-145 C. and pressure range of 100-250 atmospheres.

Commercial Installations: A process similar to this is employed by Standard Oil Company, Baton Rouge, La., Gulf Oil Company, Port Arthur, Texas, Tennessee Eastman Company, Longview, Texas.

References: PETROLEUM REFINER, Dec.,1954,p141; *Chemical and Engineering News,* Feb.14,1955,Vol.33,No. 7,p594.



Pentaerythritol

Application: A process for the manufacture of pentaerythritol, $C(CH_2OH)_4$.

Charge: Formaldehyde, 37 wt-percent aqueous solution; acetaldehyde, 99+ percent purity.

Product: Crystalline pentaerythritol, either technical grade (85-90 percent purity) or nitration grade (99 percent purity).

Description: Pentaerythritol is produced commercially by a batchwise reaction between formaldehyde and acetaldehyde in an alkaline medium. Chemically, two successive reactions take place. In the first, an alkali-catalyzed aldol condensation produces pentaerythritose:

$$3\,HCHO + CH_3CHO \xrightarrow{\text{alkali}} C(CH_2OH)_3CHO$$

In the second step, the alkali (here shown as calcium hydroxyde) enters the reaction process, and monopentaerythritol is formed:

$$HCHO + C(CH_2OH)_3CHO + Ca(OH)_2 \rightarrow C(CH_2OH)_4 + Ca(COOH)_2$$

In practice, both reactions occur during a single batch operation. The reactor is of conventional design, being equipped with cooling coils and jacket, and mechanical agitator.

Weighed amounts of formaldehyde solution and lime slurry are placed in the reactor, the amount of lime being 10-15 percent in excess of that required stoichiometrically. Water is then added to adjust the formaldehyde concentration to about 15 percent. Liquid acetaldehyde is next introduced beneath the liquid surface, agitation and cooling being controlled to give a mixing temperature of 70-80 F. The acetaldehyde addition is complete when the formaldehyde:acetaldehyde molar ratio is 4.5-5.0 to 1.0.

The reaction is carried out for several hours, with the temperature being varied from 80 to 140 F. Careful attention must be given to the time-temperature relationship in order to insure a product of good quality and yield. Overheating causes formation of complex sugars which contaminate the product. Underheating causes uneconomically-long reaction times and inadequate yields. In general, some 4-5 hours are required, during most of which the reactor contents are below 100 F. In this discussion, lime is considered as the alkali in accordance with general practice, but caustic soda is also used.

When the reactor contents show a total aldehyde concentration of less than 0.1 percent, they are pumped to the neutralizing tank where dilute sulfuric acid is added to lower the pH to about 8.0. This precipitates calcium sulfate, which is in turn filtered off. If sodium hydroxide is used in the process, neutralization is effected by formic acid and this filtration step is not required, since the sodium formate is soluble.

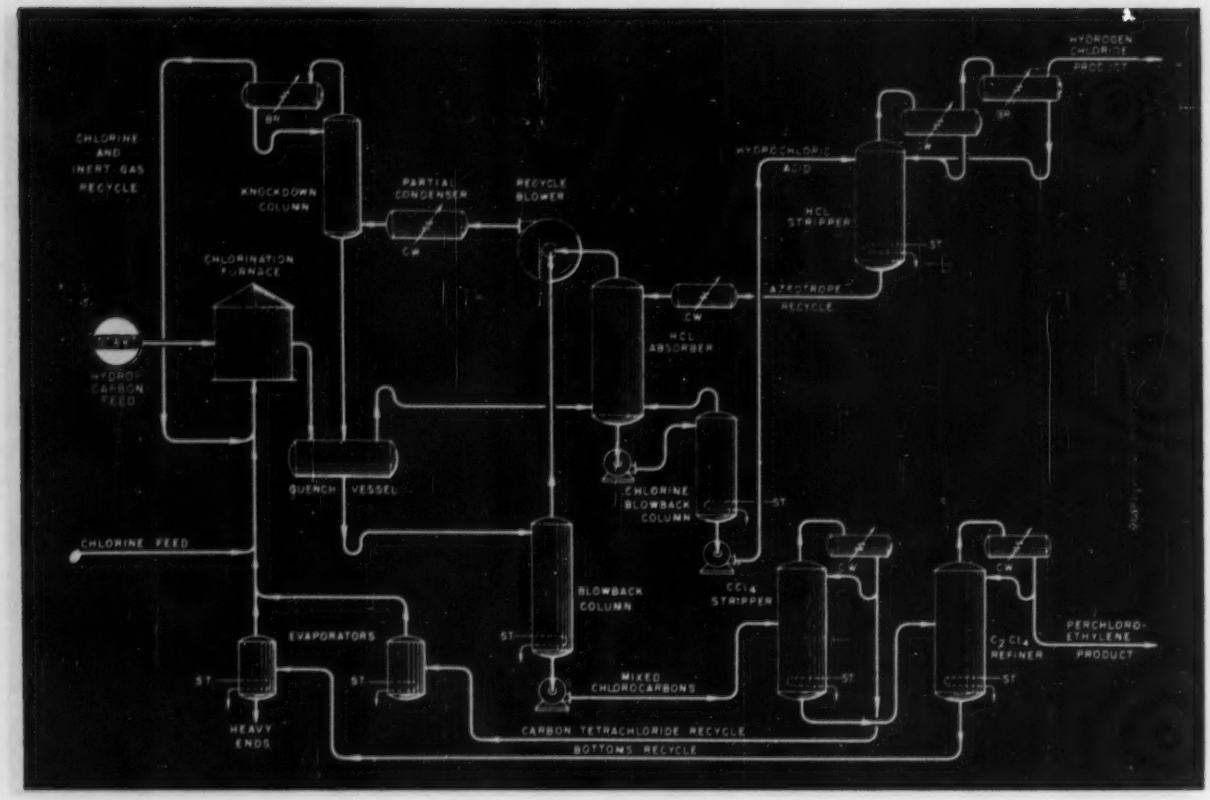
The filtrate passes to a vacuum evaporator where most of the water is removed. The thick liquor has a specific gravity of about 1.27 and contains some precipitated pentaerythritol. Precipitation is completed in a water-cooled vessel, and the crystals separated by centrifuging. The mother liquor is recycled to the evaporator for further recovery of pentaerythritol. The moist crystals are dried to yield technical grade product, which contains some 85-90 percent monopentaerythritol with dipentaerythritol as the principal impurity. About 90 percent of the industrial production of pentaerythritol is technical grade.

For the production of nitration-grade material, the technical product is re-dissolved in hot water, decolorized with charcoal, and filtered at 170 F. or higher. The filtrate is then cooled, with essentially pure monopentaerythritol crystallizing out. The crystals are separated by centrifuging and finally dried to yield the nitration-grade product of 99 percent purity.

Yields: The yield of total pentaerythritols is 85-90 percent, based on acetaldehyde charged.

Commercial Installations: This process or a modification is used by: Commercial Solvents Corporation, Agnew, Calif.; Delaware Chemicals, Inc., Staten Island, N. Y.; Hercules Powder Company, Mansfield, Mass., and Louisiana, Mo. (under construction); Heyden Chemical Company, Garfield, N. J.; Reichhold Chemicals Company, Tuscaloosa, Ala.; St. Maurice Chemicals, Ltd., Varennes, Quebec; Trojan Powder Company, Seiple, Pa.; Warren Petroleum Company, Conroe, Texas.

Reference: Reaction variables are discussed by M. S. Peters and J. A. Quinn, *Ind. Eng. Chem.*, Vol.47,1710(1955).



Perchloroethylene

SCIENTIFIC DESIGN COMPANY, INC.

Application: A process to produce perchloroethylene.

Charge: Oxygen free chlorine and an inert free hydrocarbon such as natural gas, LPG, or any mixture lighter than butane.

Products: The principal product is refined perchloroethylene, C_2Cl_4.

Description of Process: Chlorine, hydrocarbon, and several recycle streams are mixed and fed to the chlorination furnace. The chlorination process proceeds readily at high temperatures, sustained by the heat of reaction, without the aid of catalyst. From the furnace the reaction products go to a quench vessel where they are suddenly cooled.

The liquid quench mixture, consisting of carbon tetrachloride, perchloroethylene, and quench medium is stripped in a blowback column.

The mixed chlorocarbons from the stripping column are then fractionated first in a carbon tetrachloride stripper. The carbon tetrachloride overhead is recycled to the furnace. The remaining crude perchloroethylene is refined to yield high purity product, and the bottoms from the refining column are also recycled to the furnace.

Unquenched gases from the quench vessel pass to an HCl absorber where hydrogen chloride is absorbed in weak acid. The remaining gases from this absorption column are compressed by a recycle blower. Excess chlorine from the absorption system passes through a rectifying column. The excess chlorine overhead is recycled to the furnace.

The strong hydrochloric acid from the HCl absorber is also partially stripped to remove traces of dissolved chlorine and other contaminants which are returned to the HCl absorber. The purified hydrochloric acid is then sent to a conventional HCl stripping system, which yields anhydrous hydrogen chloride gas as the by-product of the process. Weak acid, close to the azeotropic composition, is recycled as scrubber liquor.

All equipment is of corrosion resistant alloy or nonmetallic material of construction. In particular equipment which handles hydrogen chloride is fabricated with a ceramic lining or of impervious graphite. The chlorination furnace and the quench vessel pose extremely stringent problems in mechanical design, and involve some radically new techniques of fabrication.

Possible chemical reactions depend upon the hydrocarbon feedstock. The following are examples:

(1) $2\,CH_4 + 6\,Cl_2 \rightarrow C_2Cl_4 + 8\,HCl$

(2) $2\,C_2H_6 + 10\,Cl_2 \rightarrow 2\,C_2Cl_4 + 12\,HCl$

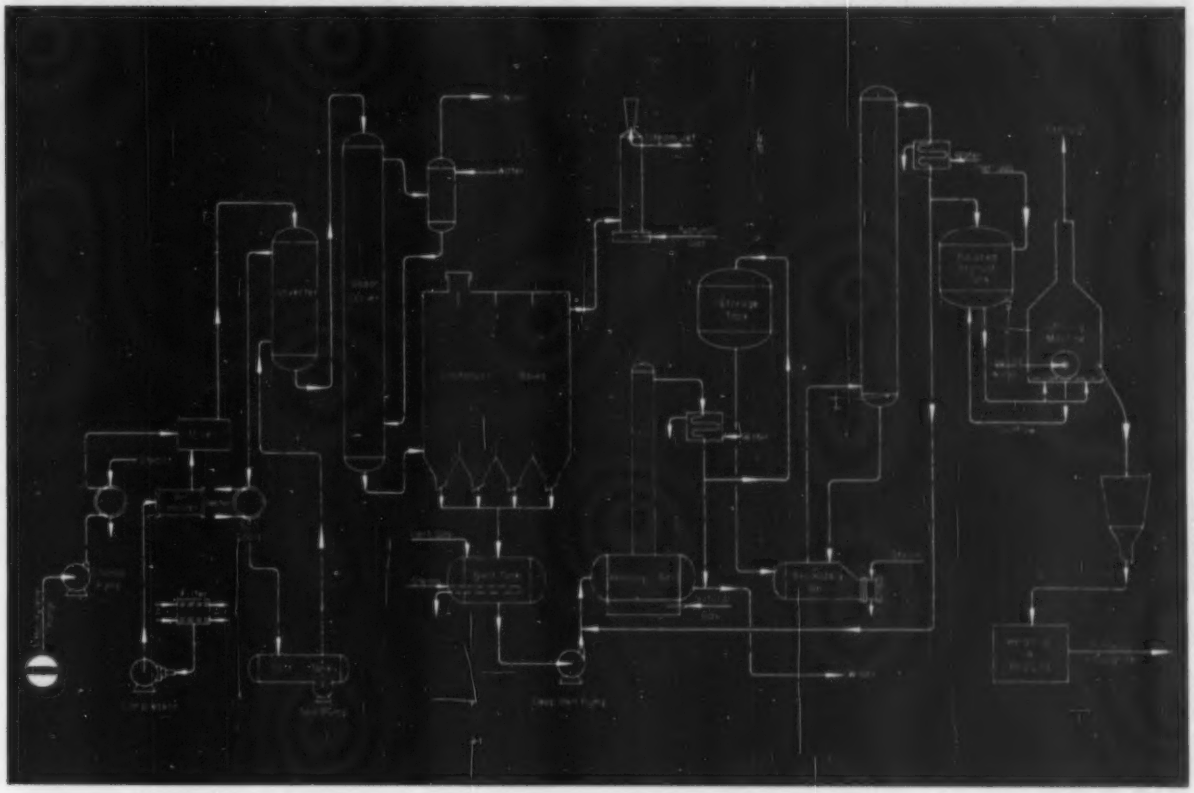
(3) $2\,C_3H_8 + 14\,Cl_2 \rightarrow 3\,C_2Cl_4 + 16\,HCl$

Operating Conditions: The chlorination furnace operates near atmospheric pressure at a temperature of 900-1200 F. The quench vessel, where rapid quenching is essential, operates at a low temperature. The absorption, stripping and fractionating columns operate at moderate temperatures and pressures.

Yields: The yield of products approaches 100% of theoretical. For example, one plant was designed to yield 20 pounds of perchloroethylene and 27 pounds of hydrogen chloride from 45 pounds of chlorine and 4 pounds of propane.

Commercial Installations: Pechiney Compagnie de Produits Chimiques et Electrométallurgiques is completing construction of a large perchloroethylene plant at St. Auban, France.

Reference: PETROLEUM REFINER, Oct., '54, p. 131.



Phthalic Anhydride

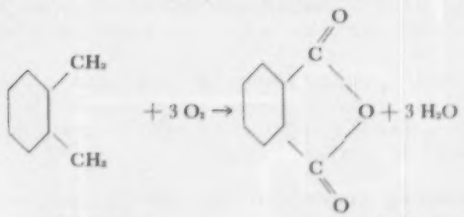
CALIFORNIA RESEARCH CORPORATION

Application: This process is applied to the manufacture of phthalic anhydride.

Charge: The charge is ortho-xylene.

Product: The product is solid phthalic anhydride.

Description: The liquid ortho-xylene feed is pumped at controlled rates into steam-heated vaporizers. The vaporized xylene is fed to a mixer where it is contacted with heated air. This mixture then goes to salt-cooled converter units where the following reaction occurs:



O-Xylene Phthalic Anhydride

This direct oxidation of the xylene to phthalic anhydride is promoted by the catalyst in the converter tubes which is based on vanadium pentoxide (V_2O_5). This catalyst must be carefully prepared for proper catalyst activity.

The reacted mass leaving the bottom of the converters passes through tubular heat exchangers where the gases are cooled before passing into condensers. The crude phthalic anhydride crystals deposited in the condenser units are withdrawn at regular intervals. The spent gases passing from the condensers go into furnaces fitted with gas burners so as to eliminate fume nuisance.

The crystals of crude phthalic anhydride removed from the condensers are melted in steam-heated melt tanks, the molten anhydride being distilled batchwise in two distillation stills in series. Free and combined water is taken off as the first cut from the primary still. The second cut, containing the phthalic anhydride and light boilers such as maleic anhydride, is taken off under vacuum and fed to the secondary still. Condensing phthalic anhydride must be held above its melting point to prevent operational difficulties due to solidification in tubes and transfer passages. The purified phthalic anhydride is removed as an overhead stream from the second distillation still which also operates under vacuum. The bottoms in the secondary still are returned to the primary still. The product goes from the secondary still to an aluminum storage tank. From this tank it is fed to a stainless-steel water-cooled surface for solidification. The final product in the form of chips is weighed and packed in paper bags.

Operating Conditions: The most important operating conditions are the air/hydrocarbon ratio, the temperature in the converter and the contact time. Typical operating ranges for these variables are given below:

Air/Hydrocarbon Ratio	25-30
Temperature, F.	750-880
Contact Time, seconds	0.6

Commercial Installation: Standard Oil Company, Richmond, Calif.

Reference: Petroleum Refiner, Oct.'53,p113.

Phenol and Acetone from Cumene

Application: A process for manufacturing synthetic phenol from cumene.

Charge: Cumene (isopropylbenzene), air, hydrogen, dilute sulfuric acid.

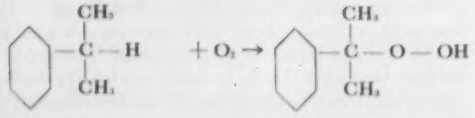
Products: Phenol (42.5-43 °C m. p.), acetone, acetophenone.

Description: Raw material cumene is obtained from the alkylation of benzene with propylene over a phosphoric acid catalyst. The propylene is usually derived from the products of propane cracking. The cumene is fractionated to a high degree of purity before being charged to the phenol unit.

Fresh and recycle cumene in a ratio of about 1:4 are mixed and sent to the hydrogenator. The recycle cumene contains about one percent alpha-methylstyrene and this must be removed before the cumene is oxidized. Hydrogen gas is bled into the reactor and the adpha-methylstyrene is converted directly to cumene. A suspended nickel catalyst is employed, together with mechanical agitation and a temperature of about 210 F. The effluent liquid contains less than 50 ppm alpha-methylstyrene.

The purified cumene is decanted from the catalyst, filtered, and pumped to the oxidizer. Intermediate storage is provided in order to buffer flow surges.

The oxidizer is a vessel containing an agitated oil-water emulsion. The contents are maintained at 265 F. Emulsifying agents such as sodium stearate or sodium lauryl sulfate are used. Air is injected under the surface and supplies the oxygen for reaction. An excess of cumene is used in order to utilize a substantial portion of the oxygen in the air. Cumene hydroperoxide is produced according to the reaction:

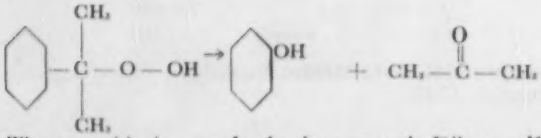


About 25 percent of the cumene is converted per pass. The liquid effluent is separated from fixed gases and sent to the cleavage vessel.

The reason for the oxidation being carried out in a dispersion of the hydrocarbon in an alkaline aqueous medium is to increase the rate of oxidation of benzene peroxide formation. The optimum conditions are with a pH of 8.5 to 10.5 which is easily maintained by using a sodium carbonate buffered solution.

Best results are obtained by using emulsifying agents. Sodium sterate of about 0.3 percent concentration seems to give best results. Other variables that effect this oxidation rate are: ratio of water and oil phases; peroxide concentration in the reaction mixture.

In the cleavage step the peroxide is decomposed by boiling it under pressure in the presence of an acid. The reaction which occurs is:



The peroxide is completely decomposed. Dilute sulfuric acid is used and continuously recycled. The reactor effluent flows to a separator from which the oil layer, or crude phenol, is removed for further processing. The equeous layer is recycled to the cleavage vessel.

Residual acid is removed from the crude phenol by countercurrent scrubbing with water in a packed tower. The washed oil has the following approximate composition:

	b.p., °F.	Weight-percent
Acetone	134	8
Cumene	307	76
Alpha-Methylstyrene	330	1
Phenol	359	14
Acetophenone	396	1
		100

Phenol, acetone, and acetophenone are of commercial importance and are separated individually. Alpha-methylstyrene has uses in plastics manufacture and in some cases is separated. In the process described here it is converted to cumene.

The crude phenol is pumped to a fractionating column which operates at atmospheric pressure. Acetone is separated as overhead product. The bottoms stream passes to the cumene tower. This tower operates under vacuum and removes cumene and alpha-methylstyrene as overhead product. These materials are recycled to the hydrogenator. At this point an additional fractionator may be employed for the purpose of separating alpha-methylstyrene.

The bottoms stream from the cumene tower contains about six percent acetophenone and the remainder essentially phenol. This material passes to the phenol tower, which also operates under vacuum. The product phenol passing overhead is condensed at about 120 F. and crystallized in a special receiver. The bottoms stream contains about 15 percent phenol and the remainder acetophenone.

The importance of this process is that it provides substitution on an aromatic ring without chlorinating or sulfonating. Thus chlorine and sulfuric acid, both of which are at times in short supply, are not needed. A very small amount of sulfuric acid is used as catalyst, as mentioned above, and other acids, such as phosphoric, may be substituted for it.

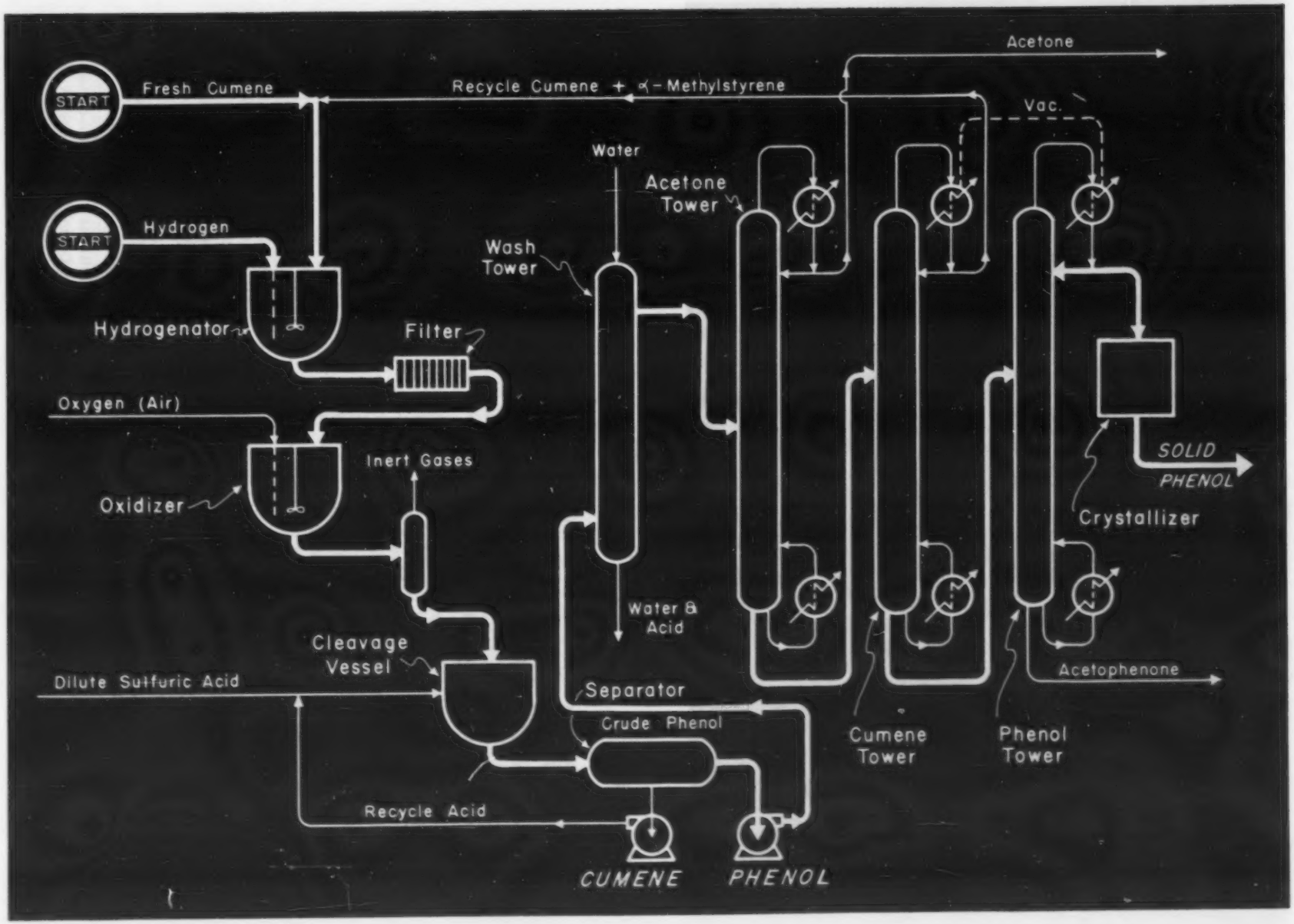
Another important feature of this process is that substantial quantities of acetone are produced. The credit for this valuable by-product strongly influences the economics of the process.

Operating Conditions: The principal conditions for the oxidation and cleavage steps are given in the above text.

Yields: The over-all process yield, from raw material cumene to finished phenol, is about 93 percent of theory.

Commercial Installations: British American-Shawinigan, Ltd., Montreal East, Canada; Barrett Division of Allied Chemical and Dye Corporation, Frankford, Pa.; Hercules Powder Company, Gibbstown, N. J.; Oronite Chemical Company, Richmond, Calif.

Reference: Petroleum Refiner, Aug.'53,p.123.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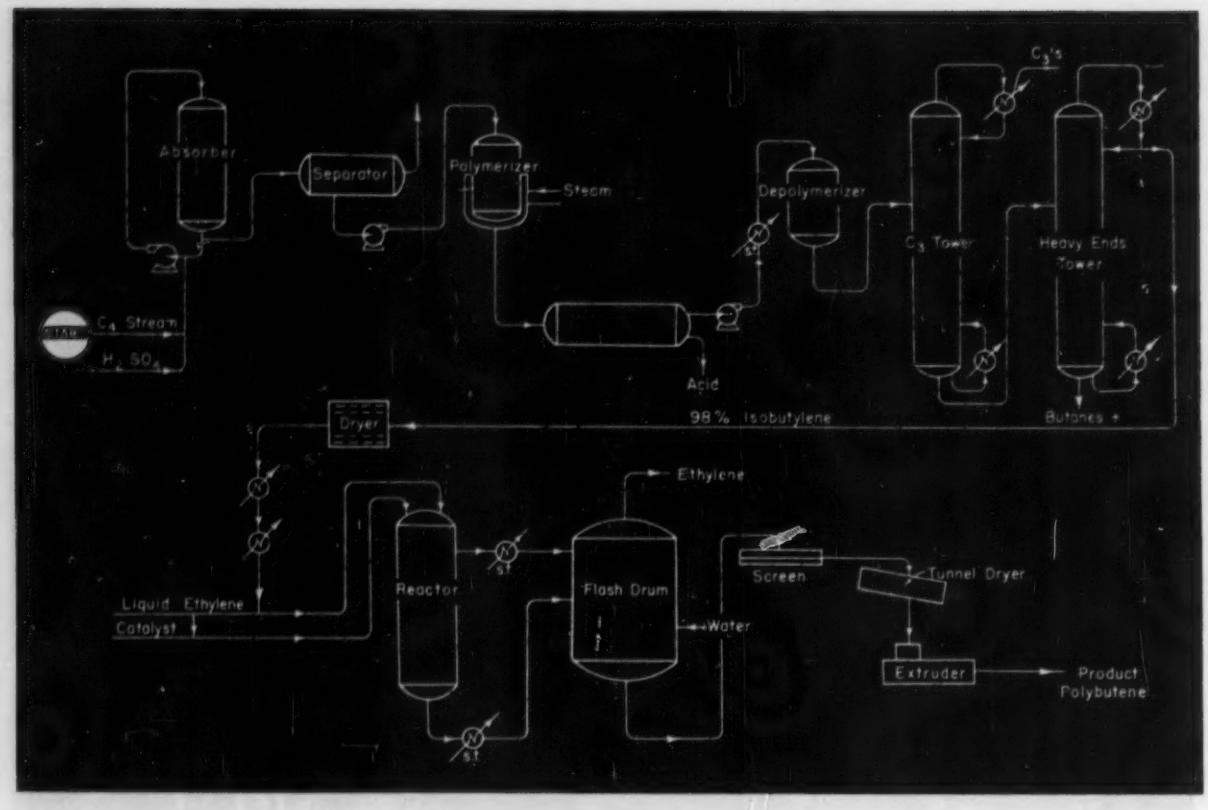
Fresh Cumene
Recycle Cumene + α-Methylstyrene
Acetone
Vac.
START
Hydrogen
Water
Acetone Tower
Wash Tower
Hydrogenator
Filter
Oxygen (Air)
Inert Gases
Oxidizer
Crystallizer
SOLID PHENOL
Water & Acid
Cleavage Vessel
Dilute Sulfuric Acid
Separator
Crude Phenol
Acetophenone
Cumene Tower
Phenol Tower
Recycle Acid
CUMENE
PHENOL



Polybutene

Application: Processes for manufacturing solid and liquid polybutene (polyisobutylene).

Charge: Refinery C_4 hydrocarbon fraction.

Product: Solid polybutene, 200,000 molecular weight; liquid polybutene, 10,000 molecular weight.

Description: Polybutene is polymerized isobultylene of varying molecular weight. Two general types of polybutene are produced commercially: the solid, rubber-like high polymer and the viscous liquid low polymer. Typical processes for producing both types will be described briefly.

The specific raw material for the polymerization is 98 percent isobutylene. This can be obtained from refinery C_4s by an isobutylene extraction process described in this handbook.

For high-polymer production, isobutylene is dried and chilled to —150 F. in successive ammonia and ethylene refrigerant exchangers. It is then mixed with liquid ethylene (1:1 ratio), also at —150 F., and fed continuously to the reactor. A second stream of liquid ethylene, containing about 0.1 percent boron trifluoride catalyst, is fed to the reactor simultaneously. The reactor is a vertical vessel provided with means for violent agitation.

The polymerization reaction is rapid and exothermic. Heat removal is provided by vaporization of ethylene. Operating conditions are about —140 F. and atmospheric pressure. A solution polymerization technique of this nature produces a polymer of about 200,000 average molecular weight.

The effluent passes to a flash drum maintained at +150 F. where unreacted isobutylene, ethylene, and catalyst are removed. Water is added to the residue and the slurry passed through screens where most of the water is removed. The wet polymer is dried at 150-220 F. in a tunnel drier, and finally extruded. The final product is a close kin of butyl rubber, which contains small amounts of polymerized isoprene.

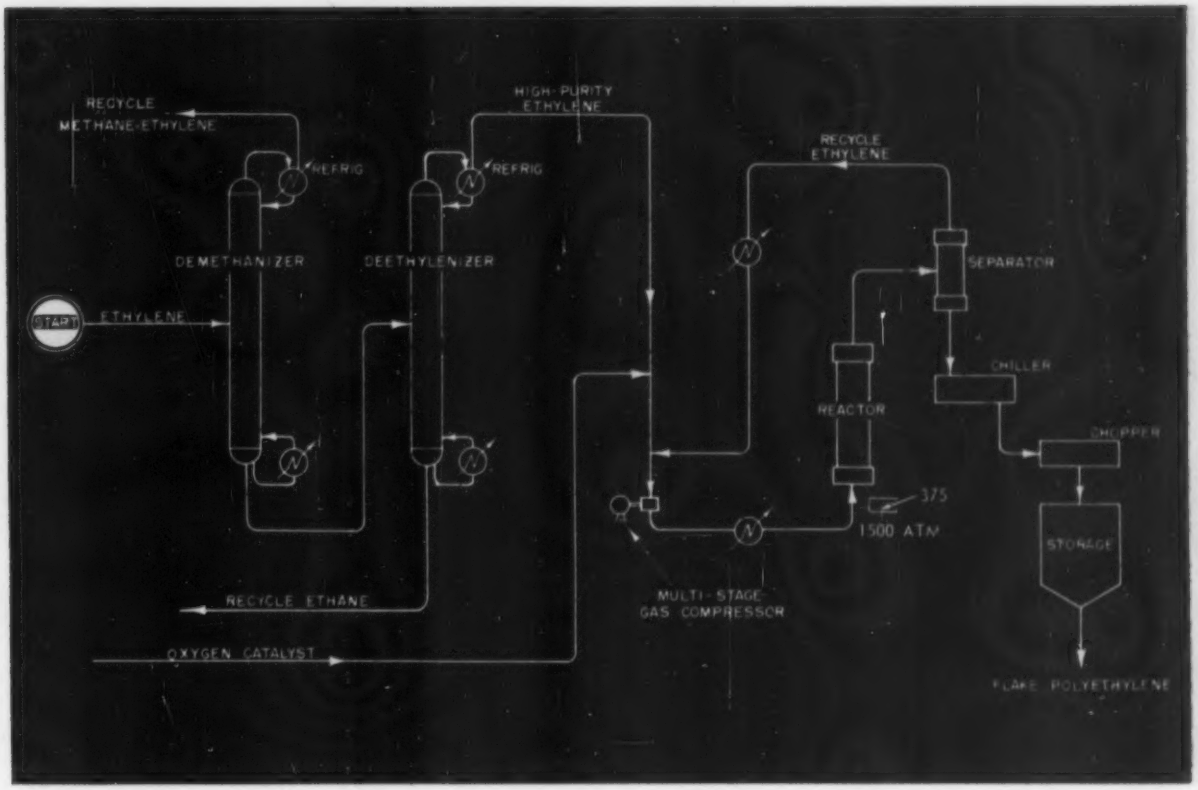
For low polymer, a solvent of isobutane and a temperature of about 15 F. are used. Boron trifluoride is the catalyst. The operations are similar to those described for high polymer, except for the final processing steps. The product, a liquid of high viscosity and tackiness, is taken directly from the flash drum.

Polybutenes are also used as viscosity improvers in lube oils, rubber modifiers, textile lubricants, adhesives and for the impregnation of leather. Isobutylene is the only strictly aliphatic olefin which is polymerized extensively for the production of plastic material other than synthetic rubber.

Yields: Over-all yield of polymer, based on purified isobutylene, is 95-98 percent..

Commercial Installations: Indoil Chemical Company, Whiting, Ind.; Oronite Chemical Company, Richmond, Calif.; Enjay Company, Bayway, N. J.

Reference: Petroleum Refiner, June'54, p155.



Polyethylene (High Pressure-ICI)

Application: A process for the continuous manufacture of polyethylene.

Charge: Ethylene gas of 90-95 percent purity.

Product: Solid polyethylene.

Description: Polyethylene manufacture requires high purity ethylene and the first step is to purify the ethylene plant product.

The first purification column is the deethanizer in which the overhead, consisting of methane-ethylene, is taken back to the ethylene plant and the bottoms to the second tower where 99.8-99.9 percent ethylene is taken overhead with the bottoms going back to the ethylene plant.

In the **mass polymerization** process, an operating pressure of about 1500 atmospheres is used. About 600 ppm of oxygen in the reactor charge serves as catalyst. The mixture is heated to 375 F. and fed to a stainless-steel tubular reactor. Once initiated the reaction proceeds quite rapidly with about 25 percent of the ethylene being converted to high molecular weight polymer. Special means are provided to maintain essentially isothermal conditions of 375 F.

The effluent from the reactor passes to a separator vessel in which unconverted ethylene is removed and recycled to an intermediate stage of the charge gas compressor. This ethylene contains no oxygen which, though serving as catalyst or initiator, is consumed in the reaction.

The liquid from the separator is water-white polyethylene with a viscosity about that of molasses. It is chilled quickly, and solidifies in the vicinity of 230 F. Final steps in the process are chopping, bin storage, sacking and shipping.

In the **solvent polymerization** process, an operating pressure of about 1000 atmospheres is used. An aromatic hydrocarbon is added as a solvent to improve polymer solubility in the reaction zone and thus permit easier and quicker removal of the formed polymer before it is attacked by growing polymer chains which can result in cross-linking. A mixture of fresh and recycle ethylene, plus about 20 ppm oxygen catalyst, is dissolved in a benzene-water mixture at 375 F. The major constituents in the charge have a weight ratio of about 1.0:1.0:1.5 ethylene:benzene:water. The water contains 100 ppm of oxygen. The charge is fed to a stainless-steel tubular reactor and during the course of reaction additional water is injected to maintain a more constant catalyst concentration throughout the reactor. About 17 percent of the ethylene is converted to polymer. Isothermal conditions of 375 F. are maintained. The effluent from the reactor passes to a separator where the unconverted ethylene is removed and recycled as in the mass process. The liquid, consisting of polymer, benzene, and water is sent to a distillation unit where benzene and water are ultimately separated from the heavier polymer.

In the **water-solvent** process, water carrying additional initiator is injected at multiple points along the reaction tube in order to attain a higher conversion of the ethylene per pass through the reactor. The "half-life" of these initiators normally used is low and consequently it is necessary to continually add initiator to hold up the rate of polymer formation.

The separated polymer is handled as described above for mass-polymerized ethylene.

The product polymer has a molecular weight of 18,000-30,000.

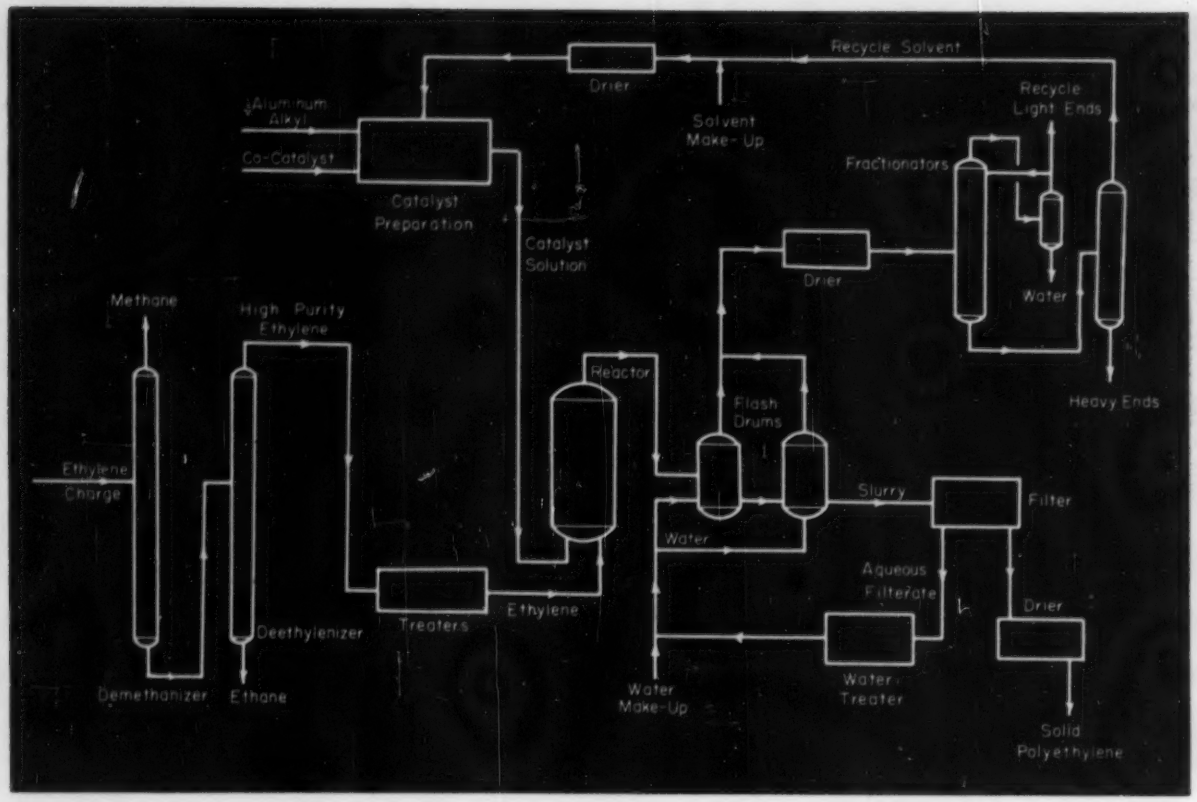
The typical processes described above are subject to variations imposed by the particular properties of polymer desired and the research findings of individual producers. Operating pressures range from 1000 to 2000 atmospheres. Tower-type as well as tubular-type reactors may be used.

Operating Conditions: The major operating variables in the polymerization reaction are temperature, pressure, and catalyst concentration. Typical values of these variables are given in the above text.

Yields: The over-all process yield of polyethylene from ethylene is about 95 percent.

Commercial Installations: Carbide and Carbon Chemicals Corporation, Charleston, W. Va.; Texas City, Texas; Seadrift, Texas; Torrance, Calif. E. I. du Pont de Nemours & Company, Orange, Texas. Canadian Industries, Ltd., Edmonton, Canada. Spencer Chemical Company, Orange, Texas. The Dow Chemical Company, Freeport, Texas. Texas Eastman Company, Longview, Texas. Monsanto Chemical Company, Texas City, Texas.

References: "The Chemistry of Petrochemical Reactions," Lewis F. Hatch.



Polyethylene (Low Pressure-Ziegler)

Application: A low pressure process for the continuous production of polyethylene.

Charge: Ethylene gas of 90-95 percent purity.

Product: Solid polyethylene.

Description: The general rule that "low-temperature polymerizations with very little catalyst are likely to produce the highest-molecular-weight polymers" finds a direct application in the polyethylene process developed by Dr. Karl Ziegler. Many details of the process are still secret —especially details related to the practical manufacture and preparation of the catalyst; however, the general principles of the process are known and are shown in the flow diagram.

A dual catalyst is used which serves to direct the polymerization. An alkyl metal, such as aluminum triethyl, promotes the polymerization of ethylene. A secondary-, or co-catalyst, which may be a finely divided metal or a metal derivative, serves to control the polymerization. Aluminum alkyls are spontaneously inflammable and normally require very careful handling. In this process, the catalyst is carried in a hydrocarbon solvent under conditions that make it safe to handle in the reaction step. Only a trace of catalyst is required, so a very dilute solution is employed.

The ethylene charge gas is demethanized and taken overhead from the deethylenizer as a 99+ percent ethylene stream. This high purity ethylene, freed of sulfur compounds, is treated to remove oxygen, water and carbon dioxide, and is then charged to the reactor. The catalyst, dissolved in a carefully dried paraffinic solvent, such as a C_6 or C_7 fraction, is charged to the reactor as a very dilute catalyst solution. The reactor is maintained at a pressure in the range of one atmosphere to 100 psig, and a temperature of 140 to 170 F.

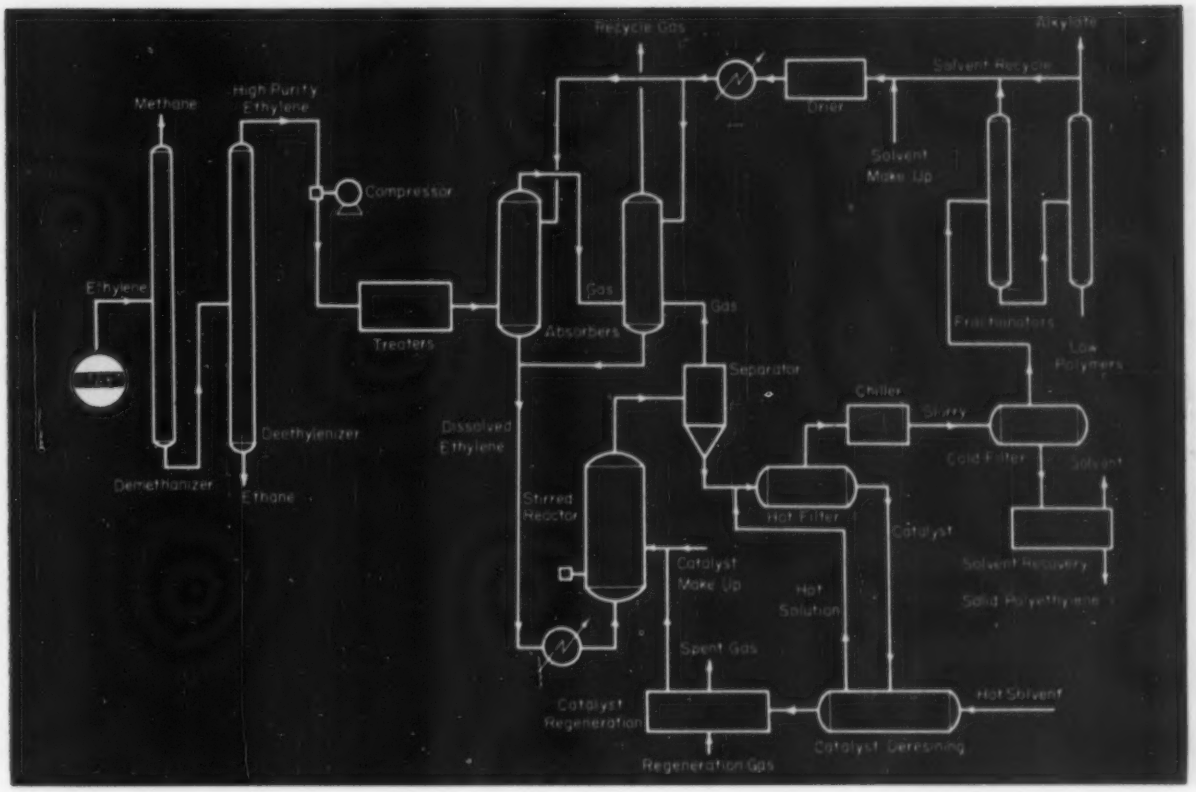
The reactor product is sent to a series of flash drums to remove the solvent and precipitate the polymer. These drums are maintained at conditions in the range of 3 to 5 psig and 150 to 160 F. Water is added to the flash drums to destroy the residual catalyst and remove the polyethylene as a slurry. The solvent is sent to a drier to remove entrained water and is then charged to a fractionator where water and light ends are removed as an azeotrope. The bottoms is sent to a second fractionator where recycle solvent is taken overhead and heavy ends are discharged as the bottoms.

The water-polyethylene slurry is sent to a filter or continuous centrifuge. The aqueous filtrate is treated and recycled to the flash drums. The solid polyethylene product is dried and sent to such finishing steps as shredding or extrusion. This product has greater rigidity and heat resistance than conventional polyethylene; however, it has poor electrical resistance because of traces of residual catalyst. The capital investment is relatively low, so it is very attractive process for polyethylene manufacture.

Operating Conditions: The principal operating conditions are given above. They are influenced by the physical properties of the solvent.

Yields: The over-all yield of polymer is in the range of 95-98 percent of the ethylene consumed.

Commercial Installations: At least nine U. S. companies are testing the Ziegler process for polyethylene manufacture. Bakelite, Carbide and Carbon, du Pont, Hercules, and Koppers have already offered at least limited commercial samples or announced plans for commercial production.



Polyethylene (Low Pressure—Phillips)

Application: A relatively low pressure process for the continuous production of polyethylene.

Charge: Ethylene gas of 90+ percent purity.

Product: Solid polyethylene.

Description: The conventional polyethylene process employs pressures in the range of 15,000 to 30,000 psi. Several relatively low-pressure catalytic processes have been developed recently.

In this relatively low-pressure process, ethylene is dissolved in a suitable hydrocarbon solvent. This solution is then contacted with the catalyst where ethylene polymerization occurs at a pressure in the range of 500 to 1500 psi and at a temperature in the approximate range of 350 to 500 F.

The ethylene charge gas, which should be free of sulfur compounds, is fed to a demethanizer. The demethanizer bottoms is charged to a deethylenizer where a 99+ percent ethylene stream is taken overhead. While lower purity ethylene may be charged to the reactor, it is desirable from the process standpoint to minimize the non-ethylene constituents. Oxygen, water and carbon dioxide are harmful to the catalyst, so they are removed by passing the high purity ethylene through appropriate treaters, such as hot metallic copper for oxygen, anhydrous calcium sulfate for water, and supported caustic for carbon dioxide.

The treated ethylene is charged to an absorber where it is contacted with a countercurrent stream of a hydrocarbon solvent, such as a xylene fraction, at a temperature in the range of 60 to 90 F. The solution from the absorbers contains 5 to 7 weight percent ethylene. The solution is brought to the desired temperature and pressure and sent to the reactor where it contacts a catalyst, such as molybdenum oxide or chromium oxide supported on an alumina or alumina-silica base. The reactor contains a stirred section to provide intimate contact of the ethylene with the catalyst. A high solvent to catalyst weight ratio is desired to provide a high yield of polymer. The solvent serves several functions in addition to its role as a carrier for the ethylene. It protects the growing polymer chain from chain-breakers, controls the viscosity of the solution, dissolves much of the solid polymer from the catalyst to help maintain good catalyst activity, controls the rate of ethylene consumption to promote good polymer growth, and it also serves as a medium for dissipation of the heat of reaction. If a solvent is not used under these reactor conditions, a polymer mixture is obtained which contains molecules as low as butene.

Catalyst is added to the reactor to compensate for that which is carried out with the reactor product. The product stream goes to a separator where the pressure is reduced to approximately 100 psi and the temperature is around 300 to 400 F. The unreacted gas is returned to an absorber, and the hot solution is sent to a filter for removal of the entrained catalyst. The catalyst is sent to a deresining chamber where additional polyethylene is recovered from the catalyst. The hot solution is combined with the separator effluent while the catalyst is sent to a regenerator.

The hot filtrate is sent to a chiller where its temperature is reduced to 75 to 150 F. This temperature reduction causes the high molecular weight polymer to separate as a solid and form a slurry with the solvent. Anti-solvents, such as propane, butane or alcohols may be added to facilitate precipitation of the polymer from the solution. The slurry is charged to the cold filter. The filtrate is sent to a fractionator where recycle solvent is recovered as the overhead. The bottoms is sent to a second fractionator which separates between alkylated xylenes and the small amount of lower molecular weight polymers formed in the process. A side reaction occurs between the xylene and ethylene in the presence of the catalyst to yield a small amount of alkylate which may be removed from the process or recycled as solvent.

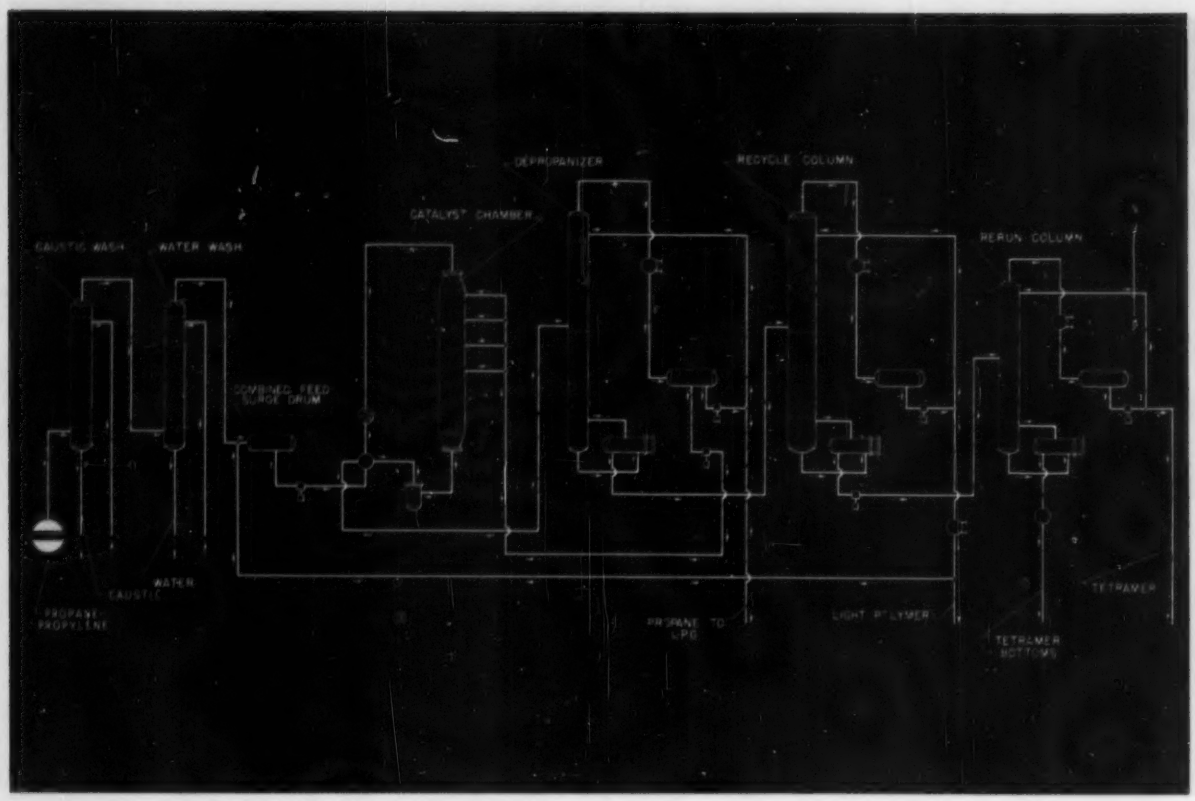
The solid polyethylene is discharged from the cold filter and sent to a final solvent recovery section, from which it may be sent to such final finishing steps as shredding or extrusion.

Operating Conditions: The principal operating conditions are given in the foregoing description. The process is operable at pressures below 500 psi.

Yields: The over-all conversion of ethylene to solid polymer is approximately 98 weight percent.

Commercial Installations: The Phillips Petroleum Company and W. R. Grace and Company will build plants that will utilize variations of the principles described here.

References: Petroleum Refiner, Aug.'55,p111.



Propylene Tetramer

UNIVERSAL OIL PRODUCTS COMPANY

Application: A process to polymerize C_3 olefins for the production of tetramer.

Charge: Propane-propylene fraction.

Product: C_{12} polymers, C_{15+} polymers, light motor polymer and propane LPG.

Description: The charge to the polymerization unit, which consists of propane-propylene, should be treated for the removal of hydrogen sulfide and basic nitrogen compounds before being charged to the catalyst section. The hydrogen sulfide removal is generally accomplished by treatment with caustic.

The removal of basic nitrogen compounds from the poly plant feed can be accomplished by the contact of the hydrocarbon stream with fresh clean water in a countercurrent wash tower.

Following the water washing operation the charge flows to a combined feed surge drum.

The charge pump takes suction from the surge drum and discharges the feed to the catalyst section which consists of beds of solid phosphoric acid catalyst. The temperature of the reaction is controlled by introducing a low olefin content stream from the fractionation section as quench between the catalyst beds.

The fractionation section consists of a depropanizer, recycle column and rerun column. These towers and their auxiliaries may be conventional in design, the net products being propane LPG, motor polymer, tetramer and tetramer bottoms. In the fractionation system the depropanized polymer product is separated into recycle and crude tetramer by the recycle column. Part of the recycle is continuously withdrawn as motor polymer.

A portion of the propane-propylene is made available as quench material to be used for the purpose of controlling the catalyst temperatures in the catalyst chambers. The net propane-propylene may be pumped as a liquid to LPG storage or used directly as fuel gas.

The recycle column controls the initial boiling point of the tetramer product. Some of the overhead is recycled back to the combined feed surge drum, with all excess overhead being pumped to motor poly storage or to blended gasoline storage. If polymer is stored separately it should be inhibited on the way to storage. If stored as a blend with other products, one of the streams should contain enough inhibitor so that the minimum concentration exists in the tank at all times.

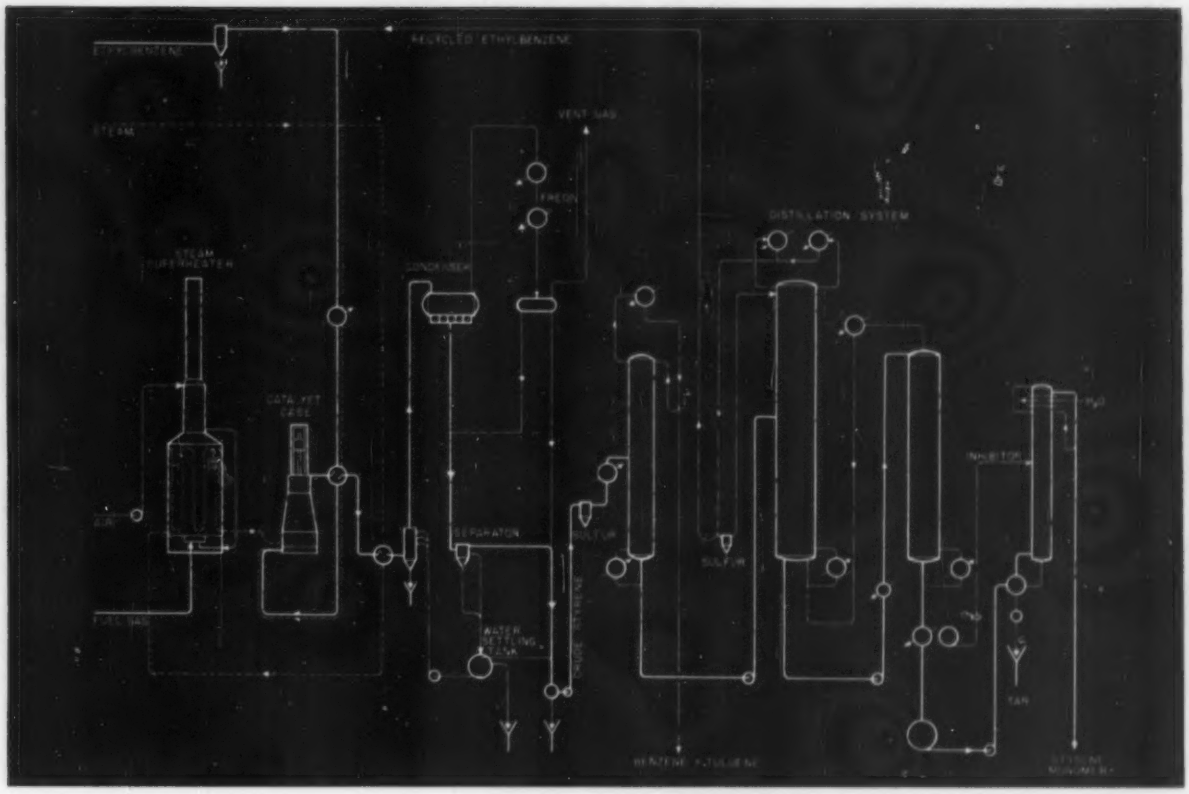
Because of the high reboiler temperature on the rerun column, operations are sometimes carried out under vacuum. The bottoms product is normally quite small and is designed to be pumped out only periodically on hand control.

Yields:

Fresh Feed:	Vol. Percent	Products:	Vol. Percent
Propylene	49.3	Tetramer 350-480 F	29.7
Propane	50.7	Heavy Polymer 480 F.-EP.	1.3
		Light Polymer I.B.P.-350 F.	0.3
		Propane LPG	54.6
			100.0

Commercial Installations: There are 21 units in operation at the present time.

Reference: Petroleum Refiner Dec.'54,p186.



Styrene

Application: This process is applied to the manufacture of styrene monomer by the catalytic dehydrogenation of ethylbenzene.

Charge: The charge is ethylbenzene.

Product: High purity styrene monomer is the product.

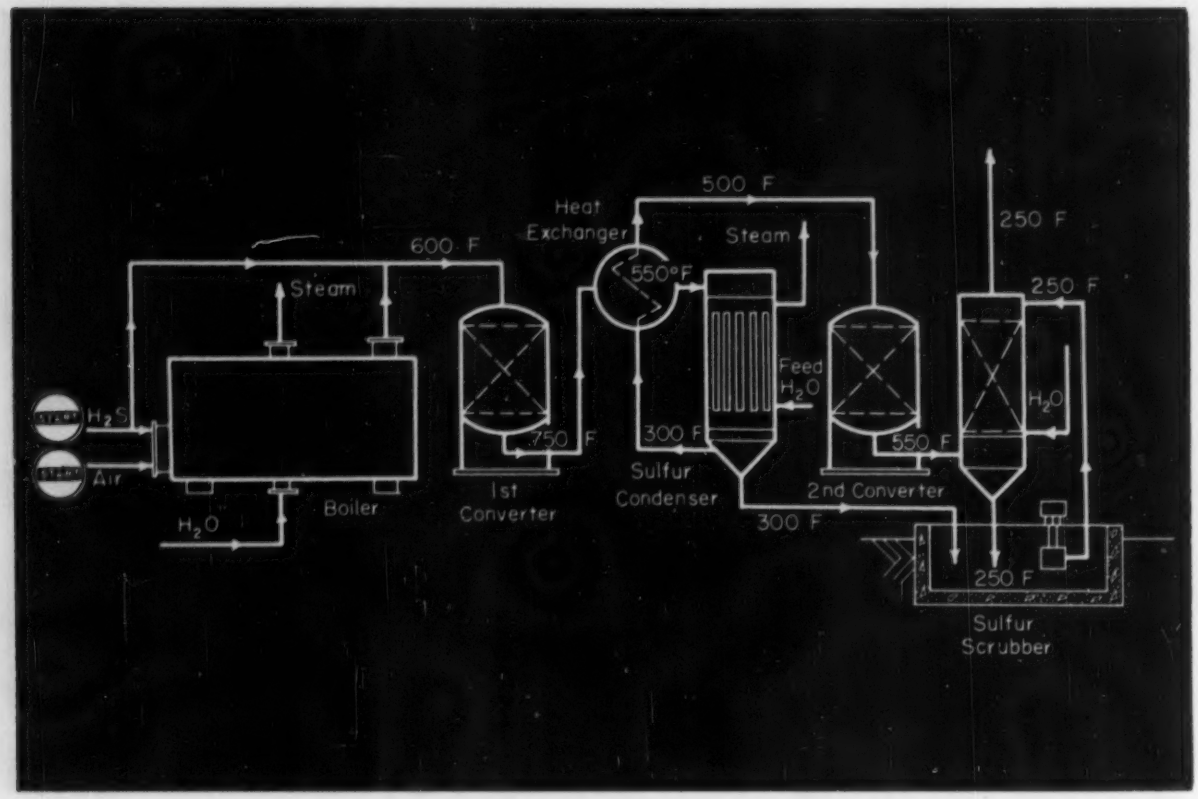
Description: Since reduced pressure favors the dehydrogenation reaction, steam is fed at a rate of 2.6 pounds per pound of ethylbenzene. About 90 percent of this steam is heated to about 725 F. before entering the superheating furnace which produces steam at 1310 F. The other 10 percent of the steam is mixed with ethylbenzene and passed through a vaporizer, being heated to 320 F. before heat exchange with hot reactor product. Ethylbenzene vapors at 970 F. are mixed with steam at 1310 F. in the reactor. The resulting temperature at the bottom of the catalyst bed is 1166 F. This temperature is the control point for the reaction system. Reactor product at 1049 F. is cooled by heat exchange, first with incoming ethylbenzene, and then with steam. From this point a spray-type desuperheater lowers the crude product temperature to 221 F. and condenses tars formed at high temperatures. Vapors then enter the final condenser, where steam, styrene, ethylbenzene, benzene, toluene, and small amounts of tar are liquefied. Vent gases containing hydrogen, carbon monoxide, carbon dioxide, methane, ethane, plus some of the aromatics pass overhead to a refrigerated recovery system.

The final step is the purification of the crude dehydrogenated material containing about 37 percent styrene. Styrene polymerization difficulties can be avoided by distilling inhibited styrene in a system which never allows the concentrated monomer to exceed 194 F. Crude styrene passes through a pot containing sulfur. Enough sulfur is dissolved to act as a polymerization inhibitor. After preheating, the feed enters the 30-plate benzene-toluene column where benzene and toluene pass overhead at 135 F. The top of this column operates at 175 mm Hg., and reflux ratio of 12 to 1 is employed. Since styrene is still diluted with ethylbenzene and tar, a temperature of 205 F. is allowable at the bottom. Sulfur passes down the column and effectively inhibits the stripping zone.

Ethylbenzene, styrene and tar are fed to the primary ethylbenzene column. To overcome the difficulties of excessively high temperature on the bottom and excessive pressure drop, the separation of ethylbenzene and styrene is effected in two steps. The primary ethylbenzene column acts as the top 38 plates and the secondary ethylbenzene column acts as the bottom 32 plates. Vacuum jets and cooling water keep the top of each at 35 mm Hg. so that bottom temperatures can be held at a safe level of 194 F.

The overhead of the primary column is ethylbenzene containing about 1 percent styrene which is recycled back to dehydrogenation feed. The bottom stream is fed to the secondary column where styrene and tar are taken out the bottom and fed to a packed batch styrene finishing still operating at 35 mm Hg. pressure. Tar and sulfur are removed in this still. An inhibitor, tertiary butyl catechol, is added to the styrene in the concentration of 10 ppm before shipment of the styrene product.

Yields. Conversion of ethylbenzene to styrene is about 37 percent per pass. Over-all yield amounts to about 90 percent.



Sulfur Recovery

THE GIRDLER COMPANY

Application: The process is applied to the recovery of elemental sulfur from hydrogen-sulfide bearing gases.

Charge: Although the acid gas stream from a Girbotol plant is an ideal feed material, almost any hydrogen sulfide or hydrogen sulfide and carbon dioxide gas mixture may be employed.

Product: The quality of the sulfur is equal to or better than bright Gulf Coast sulfur.

Description: The process is based on a modification of the original Claus process for carrying out the highly exothermic reaction:

$$H_2S + 1/2O_2 \rightarrow S + H_2O$$

In order to remove the heat generated more efficiently and maintain better control over the process the above reaction is carried out in two steps as follows:

(1) $H_2S + 3/2O_2 \rightarrow SO_2 + H_2O$
(2) $2H_2S + SO_2 \rightarrow 3S + 2H_2O$

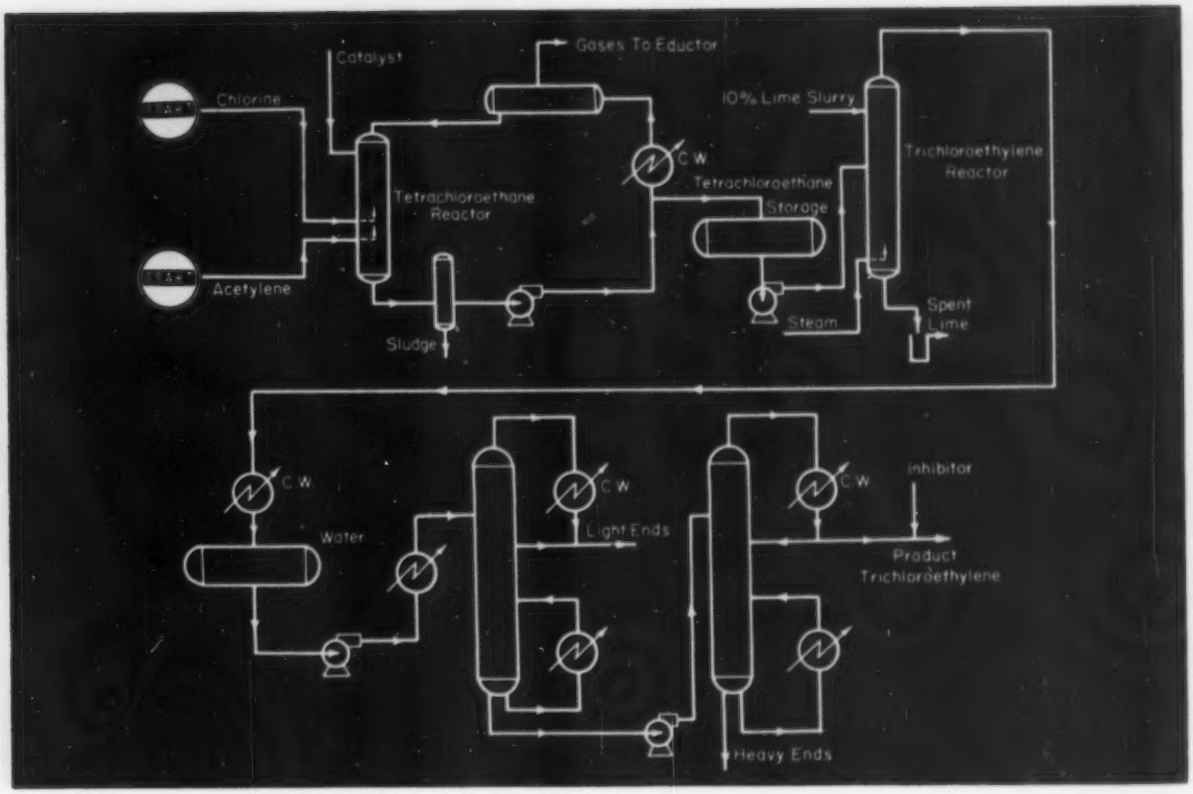
The accompanying flow plan is typical of a two stage plant and shows the approximate temperatures for a feed gas containing about 90 percent hydrogen sulfide. Reaction (1) takes place in the combustion chamber of a fire-tube boiler where approximately one-third of the hydrogen sulfide is burned to sulfur dioxide.

Following the steam boiler the gases pass through the first converter where most of reaction (2) takes place and a gas temperature rise results. It is estimated that 70-80 percent of the sulfur recovered is formed in the first stage and the balance in the second after intermediate product removal. The catalyst employed is activated bauxite which has an indefinite life, being subject only to mechanical failure.

In order to remove the sulfur formed in the first converter the gases are cooled to approximately 300 F. and the sulfur condensed. The gases are reheated before entering the second converter. Final cooling and condensation after the second converter take place in a carbon steel, Raschig ring packed scrubber where the hot gases pass countercurrent to liquid sulfur. The circulating sulfur, heated in the scrubber, returns to the sulfur tank carrying with it the newly formed sulfur. The tail gases largely consist of nitrogen, water vapor, carbon dioxide (if present originally), and small percentages of unreacted hydrogen sulfide and sulfur dioxide.

Yield: Generally a minimum of 90 percent of the sulfur present in the hydrogen sulfide may be recovered in a two-stage plant, and up to 95 percent recovery is readily attained in commercial practice. However, a single-stage plant, designed to recover 80-85 percent of the hydrogen sulfide as sulfur, may prove more economical for smaller capacity installations.

Commercial Installations: Plants are operating at the Freeport Sulphur Company, Westville, N. J., Stanolind Oil and Gas Company, North Cowden, Texas, Standard Oil Company (New Jersey) at Aruba, Netherlands West Indies, and Union Oil Co., Santa Maria, Calif.



Trichloroethylene

Application: A process for the manufacture of trichloroethylene.

Charge: Acetylene, 99 percent purity; chlorine, 99+ percent purity.

Product: Stabalized trichloroethylene, 99+ percent purity.

Description: The commercial manufacture of trichloroethylene from acetylene and chlorine consists of two main process steps: production of the intermediate tetrachloroethane and production-purification of the final product Trichloroethylene.

Acetylene and chlorine are combined in a liquid-phase, catalytic reaction to produce tetrachloroethene. The reactor is a steel tower through which a large recycle stream of tetrachloroethane reaction product is circulated. The exothermic heat of reaction is removed in an exchanger located in the circulating system.

Typical operating conditions for the reactor are: top temperature, 160 F.; bottom temperature, 195 F.; pressure, 0-5 psig; chlorine: acetylene molar feed ratio, 2.00-2.05. A catalyst such as antimony trichloride or ferric chloride is used in about 0.1 wt-percent concentration. Small amounts of hydrogen chloride and other noncondensibles are removed from the circulating system by an eductor. Other by-products include dichloroethylene and hexachloroethane, the amounts depending on the ratio of primary reactants.

Tetrachloroethane is pumped from intermediate storage to the trichloroethylene reaction tower where it is contacted with a 10 percent lime slurry. Dehydrochlorination takes place according to the reaction.

$$CHCl_2 \cdot CHCl_2 + \tfrac{1}{2}\ Ca(OH)_2 \rightarrow CHCl{:}CHCl_2 + \tfrac{1}{2}\ CaCl_2 + H_2O$$

The reactor is a steel tower filled with packing or trays, and operates at atmospheric pressure. Tetrachloroethane is boiled up in the lower section by means of live steam. The lime slurry is fed to the top of the column, thus contacting the ascending tetrachloroethane vapors. The top temperature in the tower is about 160 F., which corresponds to a crude trichloroethylene-water azeotrope containing about 7 percent water. The bottom temperature is maintained at about 215 F. which is sufficient to exclude most of the tetrachloroethane from the spent lime leaving the bottom of the tower.

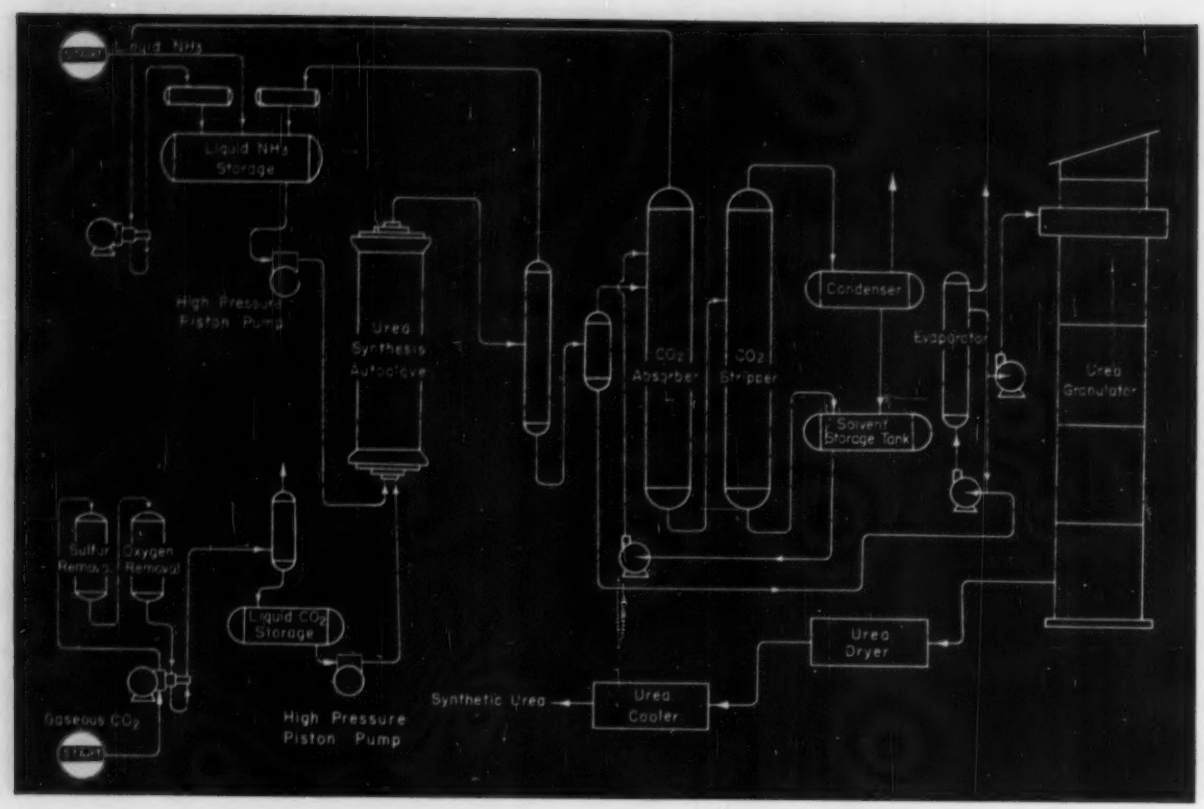
For a condition of 10 percent excess $Ca(OH)_2$, trichloroethylene is produced in 95-97 percent yield from tetrachloroethane. Conversion of tetrachloroethane is essentially complete.

The overhead stream from the reactor tower is condensed, the water separated, and the crude trichloroethylene fed to the final purification section.

Operating Conditions: Details are given in above text.

Yields: Over-all process yields, acetylene or chlorine to trichloroethylene, are on the order of 90 percent.

Commercial Installations: This process or a variation is used at the following locations: E. I. du Pont de Nemours and Co., Niagara Falls, N. Y. and Wyandotte, Michigan; Hooker-Detrex, Inc., Ashtabula, Ohio, Niagara Falls, N. Y., and Tacoma, Wash.; Niagara Alkali Company, Niagara Falls, N. Y.



Urea

CHEMICAL CONSTRUCTION COMPANY

Application: This process is applied to the manufacture of synthetic urea.

Charge: Carbon dioxide and liquid ammonia are the charge.

Product: The product is urea in the form of spherical granules.

Description: The urea synthesis plant shown in the flow diagram is designed to produce granulated urea from liquid ammonia and gaseous carbon dioxide.

The gaseous carbon dioxide enters the process system where it is first compressed and then freed of sulfur, oxygen and inert gases. The purified carbon dioxide is liquefied and pumped to a surge tank.

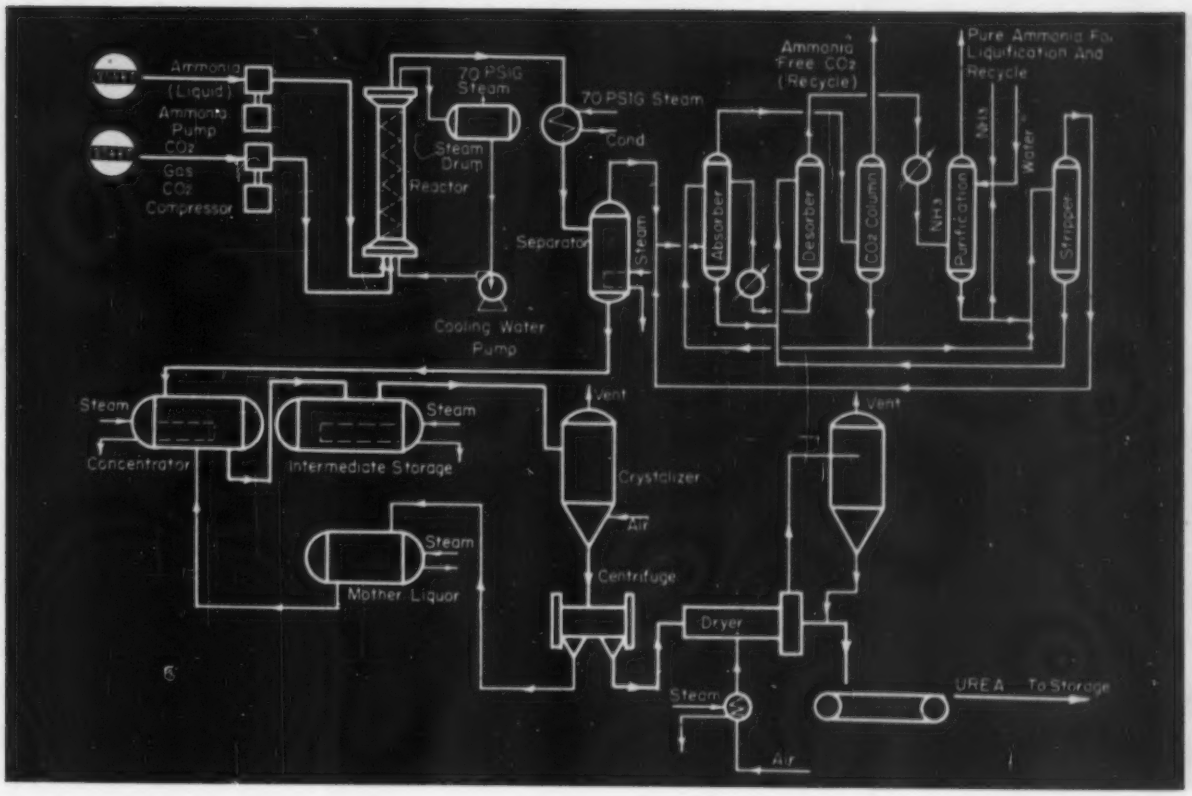
Liquid ammonia and liquid carbon dioxide are fed into the urea synthesis autoclave in the ratio of six moles of ammonia to one mole of carbon dioxide. In the autoclave one mole of carbon dioxide reacts with two moles of ammonia to form ammonium carbamate which in turn partially dehydrates to form urea. The reaction is shown by the following equation:

$$CO_2 + 2NH_3 \rightarrow \underset{\text{Ammonium Carbamate}}{H_2N\text{-}CO_2\text{-}NH_3} \rightarrow \underset{\text{Urea}}{H_2N\text{-}\overset{\overset{O}{\|}}{C}\text{-}NH_2} + H_2O$$

At the conditions prevailing in the reactor, a molal ratio of ammonia to carbon dioxide of 6:1 and a temperature of 175 C., the conversion of ammonium carbamate is approximately 76 percent. The reaction mixture leaving the autoclave, which consists of urea, water, ammonium carbamate and ammonia, undergoes a pressure reduction and flows to the recycle ammonia separator where most of the excess ammonia (four moles) is recovered at a pressure high enough to be condensed with the available cooling water. This liquefied ammonia is returned to the liquid ammonia storage tank.

The liquid reaction mixture freed of the excess ammonia undergoes another pressure reduction and enters the ammonium carbamate decomposer. In this equipment the unconverted ammonium carbamate is dissociated into the original feed materials, carbon dioxide and ammonia. The mixture of these two gases leaving the carbamate decomposer is sent to the carbon dioxide absorber where a solvent selectively absorbs the carbon dioxide from the gas mixture. This leaves a pure ammonia gas which is compressed liquefied and returned to the liquid ammonia storage tank. The carbonated solvent passes through the carbon dioxide stripper where the solvent is regenerated by removing the absorbed carbon dioxide. The regenerated solvent is then returned to the carbon dioxide absorber.

The bottoms from the carbamate decomposer, which consists of an aqueous solution of urea, is fed to the evaporator where enough water is removed so that the solution is concentrated to 95 percent urea in water. This solution is pumped to the urea granulator. The urea emerges in the form of spherical granules which are dried to remove the remaining moisture and then cooled to insure a free-flowing product.



Urea (Inventa)

Application: A process for the manufacture of Urea from carbon dioxide and ammonia.

Charge: Refrigeration grade liquid ammonia and gaseous carbon dioxide of 99+ percent purity.

Description: An important feature of this process is that both the carbon dioxide and ammonia are recycled, thus, the capacity of a given plant is not tied into the sales of other ammonia products.

The process consists of two parts, the reaction section and the recycle section. High purity gaseous carbon dioxide, compressed to approximately 200 atmospheres, and liquid ammonia are passed separately into the reactor. They react at approximately 200 atmospheres and 350-400 F. The heat of reaction is used to produce some of the process steam. A mixture of ammonium carbamate and urea forms in the reactor. The carbamate in the reactor effluent is decomposed and the ammonia and carbon dioxide flashed off. The urea solution is concentrated, filtered, and crystallized. The crystals are centrifuged and dried. The mother liquor is recycled to the crystallizer. The product from the crystallizer is plastics grade crystalline urea.

If prilled product is desired, the urea solution is pumped to the prilling tower and prilled. The prilled particles are screened and the over and undersized are put back in the pre-prilled urea solution. This prilled product is fertilizer grade urea.

In the recycle section of this process the unreacted carbon dioxide and ammonia are passed through an absorption tower which removes most of the ammonia. The rest of the ammonia is removed in a second column and the carbon dioxide can be recycled or vented. The ammonia containing absorber bottoms pass through a desorber to recover the ammonia. Another column further purifies the ammonia which is then liquified and recycled to the reactor.

Urea is used principally for the manufacture of urea formaldehyde resin, in pharmaceuticals, and as a fertilizer. It is especially desirable as a fertilizer because of the high available nitrogen content. Pure urea has a nitrogen content of 45.5 percent and commercial fertilizer based on urea has an available nitrogen content of 42 percent.

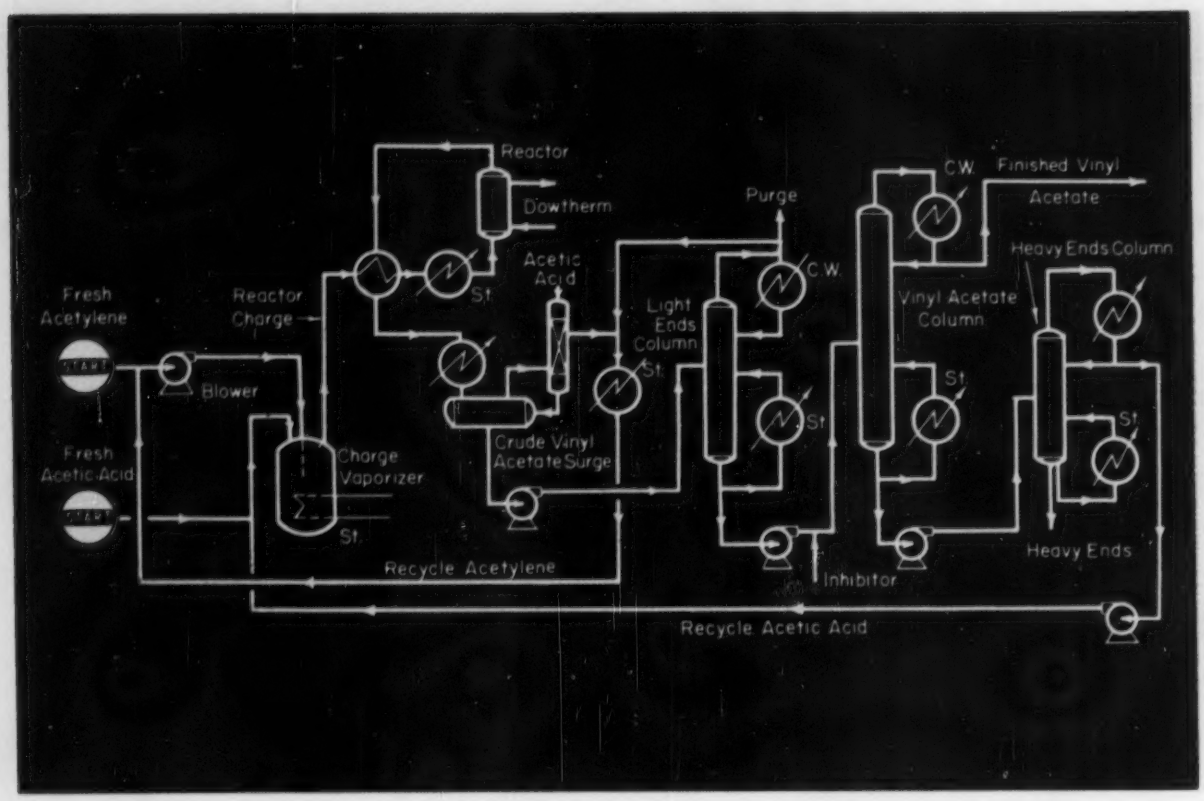
Operation Conditions: The reactor pressure is 3000 to 4000 psig. and 350-450 F.

Yields: The conversion to urea is about 50 percent per pass. The raw material requirements are approximately 55-60 tons of ammonia and 75 tons of carbon dioxide per 100 tons of product.

Commercial Installations: One commercial plant has been in operation for many years in Europe and one is under construction in the U.S. The process is available in the U.S. from the Vulcan Copper and Supply Company of Cincinnati, Ohio.

The utility requirements per ton of product are approximately: 7200 pounds of 200 psi steam; 48,000 gallons of cooling water; 450 gallons of treated process water; and 520 Kwh of 2300 volt electric power.

Reference: *Chemical Engineering*, Nov.'52.



Vinyl Acetate

Application: A process for the manufacture of monomeric vinyl acetate.

Charge: Glacial acetic acid (99.5 percent purity); acetylene, 99.5 percent purity.

Product: Vinyl acetate monomer, 99.5+ percent purity.

Description: Vinyl acetate is produced commercially by the chemical combination of acetic acid and acetylene. The reaction is catalytic and may be carried out in either the liquid or the vapor phase. The vapor phase process will be discussed here, since it has in general replaced the liquid-phase operation.

Acetylene generated from calcium carbide happens to be used in all commercial vinyl acetate plants in the United States and Canada. Certain materials present in acetylene from this source act as vinyl acetate catalyst poisons and must be removed. It will be assumed here that the acetylene contains no phosphine or sulfur compounds.

Glacial acetic acid from outside the battery limits is blended with recycle acid in the charge vaporizer, which is a stainless steel tank equipped with acetylene sparger, steam coils, and entrainment separator. Recycle plus makeup acetylene enters the tank through the sparger and passes up through the acid. The temperature of the mixture is controlled to give the desired ratio of acetylene to acetic acid in the vapor passing overhead. Typical operating conditions for the charge vaporizer are 4-5 psig pressure and a temperature of 160-180 F.

The vaporized charge is preheated first by exchange with the reactor effluent and finally with steam before it passes to the base of the reactor. The conversion to vinyl acetate takes place in a vertical tubular unit of stainless steel construction. The tubes are packed with a granular activated carbon impregnated with 20-30 weight percent zinc acetate which serves as the catalyst. The reaction is of the "hot spot" type, with the catalyst gradually deteriorating and requiring replacement every few months. For a fresh catalyst charge, the reactants are preheated to about 350 F., but as the catalyst ages the temperature is gradually increased until at the end of a cycle the reactants are preheated to about 400 F. The reaction is relatively clean at all times, with yields on the order of 95 percent of theory or better. By-products are principally acetaldehyde and ethylidene diacetate.

In addition to the temperature conditions noted, typical reaction conditions include: acetylene to acetic acid molar ratio in charge, 4-5 to 1; temperature rise of gases passing through bed, 10-20 F.; operating pressure, 2-3 psig; vapor space velocity, 300-400 hr.$^{-1}$ Acetic acid conversion is controlled to provide an optimum recycle from the distillation section, but in general is high—80 percent or more. The exothermic heat of reaction is removed by Dowtherm or equivalent medium in the shell side of the reactor.

The effluent gases from the reactor are cooled in two stages, first by exchange with feed vapors and finally in a water-cooled exchanger. A mixture of crude vinyl acetate and unreacted acetic acid is condensed and stored at ambient temperature. Noncondensibles, primarily acetylene, pass overhead and recycle to the reactor.

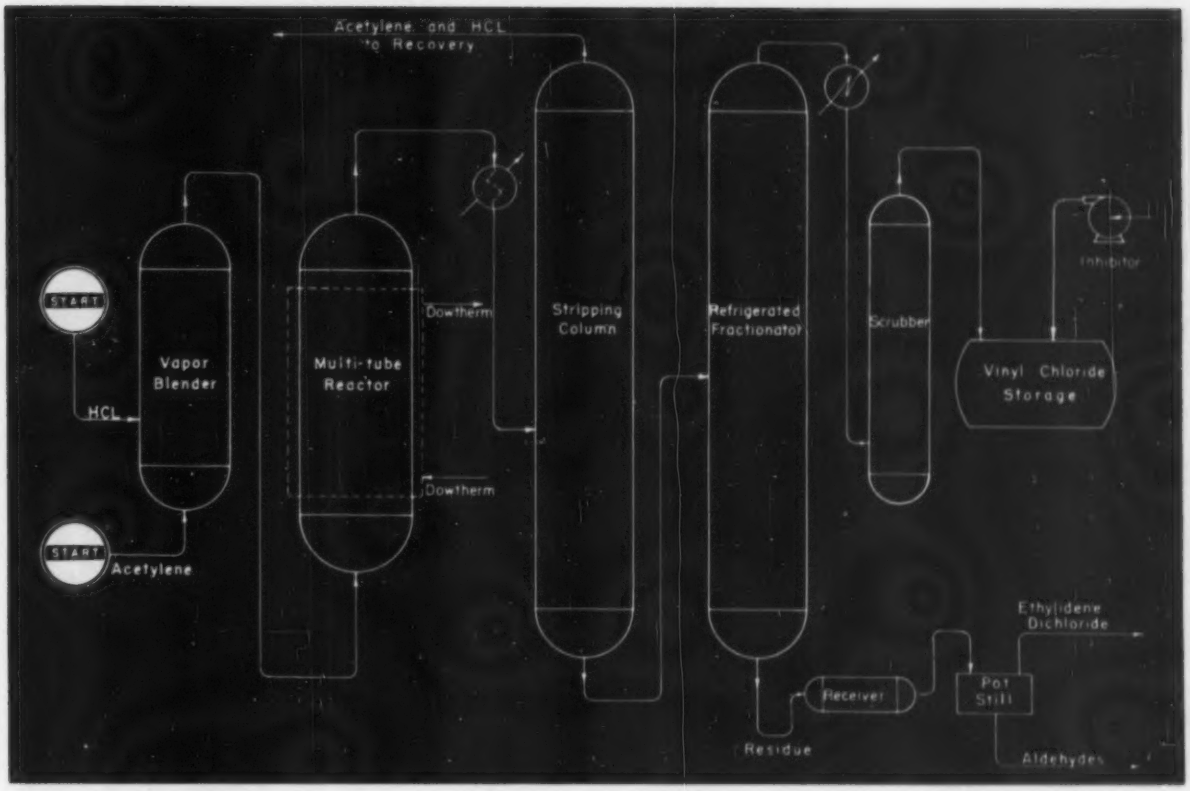
Pure vinyl acetate monomer is obtained from the crude in a series of atmospheric distillation steps. In the first column light ends such as acetylene, acetaldehyde, and acetone are removed; the acetylene is separated and recycled to the reactor. The bottoms from this column pass to the vinyl acetate finishing column, wherein a sharp separation is made between vinyl acetate and acetic acid. A polymerization inhibitor may be used in this step to prevent column fouling.

The acetic acid from the vinyl acetate column passes to a cleanup still for removal of heavy reaction products and inhibitor. The acid is then recycled to the charge vaporizer.

The finished vinyl acetate has a purity of 99.5 percent or higher. It is stabilized either with 0.03 percent diphenylamine (permanent stabilizer which must be removed before the monomer can be polymerized) or 20 ppm hydroquinone (temporary stabilizer).

Yields: Over-all process yields are 94-98 percent on acetylene, 92-95 percent on acetic acid.

Commercial Installations: This process or a variation is used at the following plants: Carbide and Carbon Chemicals Co., Niagara Falls, N. Y. and Texas City, Texas; Shawinigan Chemicals, Ltd., Shawinigan Falls, Quebec; Shawinigan Resins Corp., Springfield, Mass. The Air Reduction Co. has announced plans to build a vinyl acetate monomer plant at Calvert City, Ky. Vinyl Acetate by another process is produced at Pampa, Texas, by the Chemicals Division of Celanese Corp.



Vinyl Chlorine from Acetylene

NAUGATUCK CHEMICAL

Application: A process for the manufacture of vinyl chloride.

Charge: Acetylene and hydrogen chloride are the charge.

Product: The product is vinyl chloride monomer.

Description: Hydrogen chloride gas with a water content of less than 0.02 weight percent is mixed with dry acetylene in a vapor blender to react in equal molar quantities. Actually, about 10 percent excess hydrogen chloride is used. The hydrogen chloride must be dry to avoid excessive corrosion and to hold down the quantity of acetaldehyde formed as a by-product. From the vapor blender, the gas mixture is fed to multi-tube reactors. The reactors are connected in banks of nine for parallel flow of gases. Each tube is packed with activated carbon pellets impregnated with catalyst containing mercuric chloride.

The reaction must be initiated by heat supplied to the reaction mass using a circulating heating medium on the shell side of the reactor. Once the reaction is started, it is highly exothermic and the circulating medium used to supply heat is now used as a coolant.

The main reaction proceeds as follows:

$HC{=}CH + HCl{—}CH_2{=}CHCl$ (Vinyl Chloride).

One of the side reactions for the formation of Acetaldehyde by hydration of acetylene is as follows:

$HC = CH + H_2O — CH_3CHO$ (Acetaldehyide)

The other side reaction for the formation of ethylidene proceeds as follows: $CH_2{=}CHCl + HCl{—}CH_3CHCl_2$ (ethylidene chloride).

The temperature in the reactor is controlled between 280-400 F. The exact temperature is dependent upon the catalyst age, a higher temperature being needed as the catalyst age increases.

Gases from the reactor contain the product, vinyl chloride, as well as by-products such as ethylidene dichloride and aldehydes. Small amounts of unreacted hydrogen chloride and acetylene are also present. These gases are cooled before being fed to a combination stripping and fractionating operation. In this operation the unreacted acetylene and hydrogen chloride are removed from the crude vinyl chloride.

In a refrigerated fractionating column, the vinyl chloride is taken overhead. The ethylidene chloride and the aldehydes are removed from the bottom of this tower. These by-products then go to a pot still where the ethylidene chloride is separated from the aldehydes.

The vinyl chloride going overhead is sent to a scrubber where trace impurities are removed by caustic and water. From the scrubber, the vinyl chloride is sent to storage after the addition of a small amount of phenol which acts as a polymerization inhibitor. Storage tanks for vinyl chloride monomer are stainless steel.

Operating Conditions: The major operating conditions are given in the text of the description.

Yields: Typical yield data are given below:

Yield of vinyl chloride, based on acetylene—80-85 percent.

Acetylene consumption—42-46 pounds/100 pounds vinyl chloride.

Vinyl Chloride from Ethylene

Application: A process for manufacturing vinyl chloride from ethylene and chlorine.

Charge: Ethylene, 90-95 percent purity; chlorine, 99+ percent purity.

Product: Vinyl chloride monomer, 99.5+ percent purity.

Description: The production of vinyl chloride from ethylene and chlorine is based on the intermediate production of ethylene dichloride (1,2 dichloroethane). There are two commercially-important processes for the dehydrochlorination of the ethylene dichloride to form vinyl chloride. Both will be described below.

Ethylene Dichloride—Ethylene gas and chlorine gas are blended in a molar ratio of 1.05-1.10 to 1.00 and charged to the reactor. The reaction takes place in the liquid phase in the presence of a considerable quantity of reaction products. The exothermic reaction heat is removed either by internal cooling tubes or by circulation through an external heat exchanger. The reaction is quite rapid, and the design of the reactor is not especially critical. The reactor is usually a vertical steel vessel half-filled with ethylene dichloride. Gases are admitted through sparger pipes at the bottom of the vessel.

The reactor contents are maintained at 100-120 F. The operating pressure is 10-20 psig. Chlorine conversion is essentially 100 percent. The yield of ethylene dichloride from chlorine is 90-95 percent. The side-products include hydrogen chloride and polychloroethanes. It is sometimes feasible to add small amounts of materials such as ferric chloride or ethylene dibromide to increase the yield of ethylene dichloride.

Both vapor and liquid products are removed from the reactor. The vapors pass to a brine-cooled condenser for the recovery of ethylene dichloride and thence to a scrubbing tower where hydrogen chloride is removed with dilute caustic. The vapors finally issuing from the vent contain methane, ethylene, and ethane.

The liquid products from the reactor are washed with 6-8 percent caustic in an agitated vessel. They then pass through a coalescer to a separator tank where the lower layer of crude ethylene dichloride is withdrawn. Final purification of the ethylene dichloride is accomplished in a conventional fractionator. Product of 99+ percent purity is withdrawn and placed in storage.

Vinyl Chloride by the Thermal Process—Fresh and recycle ethylene dichloride in approximately equal proportions form the charge for this process. The charge is pumped to about 50 psig, vaporized in a steam-heated exchanger, and passed through a bed of desiccant for removal of water traces which might give corrosion problems later in the process. The dry vapor then enters the cracking furnace, which is a conventional direct-fired heater containing a plurality of stainless steel tubes. The tubes are fired such that the exit gas reaches a temperature of 900-950 F. About 50 percent of the ethylene dichloride is cracked, according to the reaction:

$$C_2H_4Cl_2 \rightarrow C_2H_3Cl + HCl$$

The yield of vinyl chloride is high, on the order of 95-98 percent. A certain amount of carbon deposition occurs, and the cracking unit must be shut down periodically for coke removal. Some operators have found it advantageous to pack the reaction section tubes with non-porous material such as smooth gravel in order to minimize skin-cracking.

The effluent gases are quenched rapidly by direct-contact with a stream of recycle ethylene dichloride. The gases from the quencher pass through a surface condenser, and the noncondensibles are finally scrubbed with water to recover the hydrogen chloride.

The combined liquid streams from quencher and condenser are pumped to a fractionation system where vinyl chloride of 99.5+ percent purity is obtained. The vinyl chloride tower operates at a sufficient pressure that the overhead stream can be totally condensed by chilled water. The product vinyl chloride monomer is stored in pressure tanks at low temperature.

Vinyl Chloride by the Caustic Process—Fresh and recycle ethylene dichloride is mixed with 6 percent caustic in a mole ratio 2:1 ethylene dichloride: sodium hydroxide and charged to a steel reactor. The reactants are pumped and heated such that the reaction conditions are approximately 150 psig and 290 F. After a residence time of 2-3 minutes the ethylene dichloride is converted to the extent of 90 percent, according to the reaction:

$$C_2H_4Cl_2 + NaOH \rightarrow C_2H_3Cl + NaCl + H_2O$$

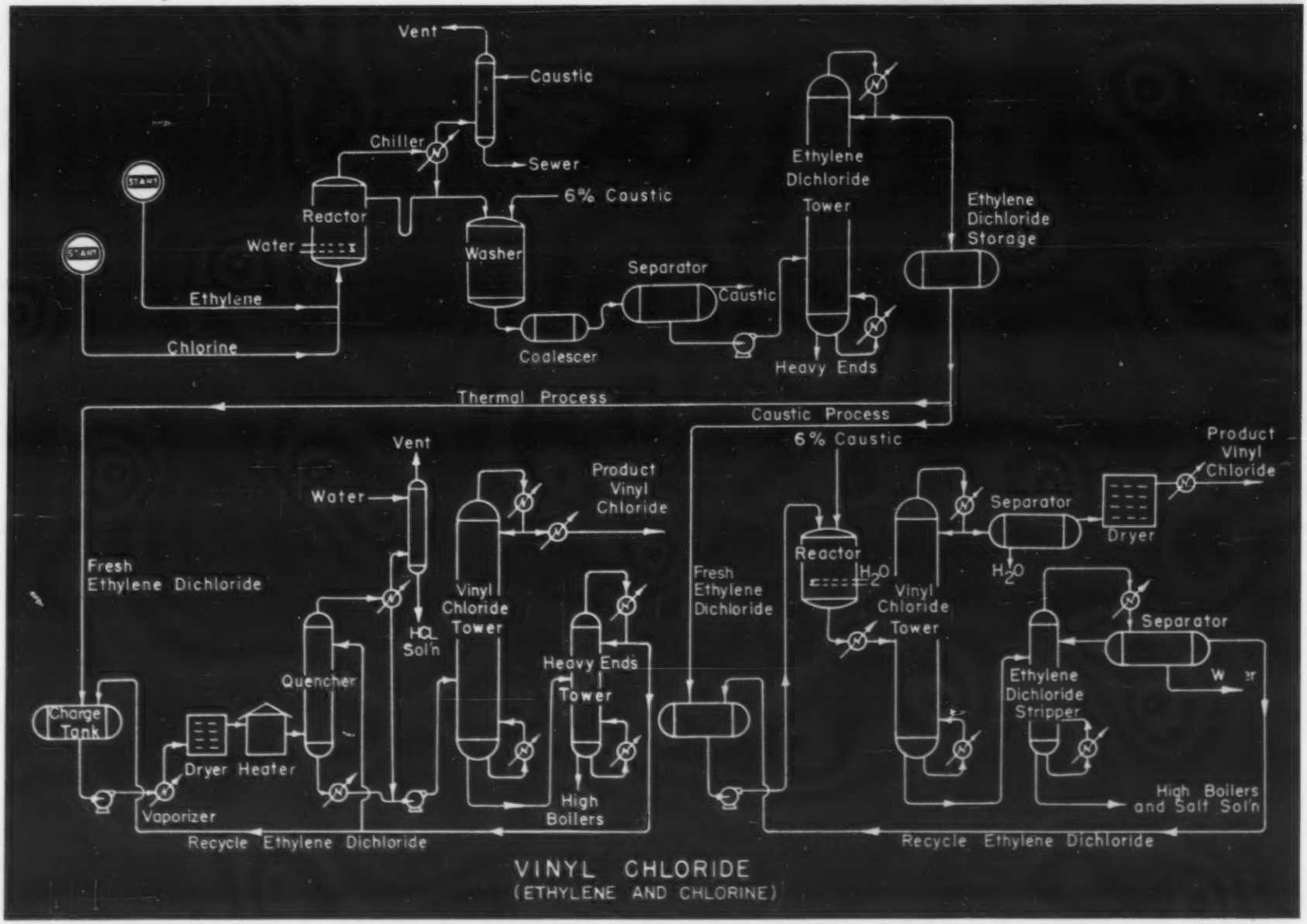
The yield of vinyl chloride is almost quantitative; minor side-products are ethylene glycol, acetylene, and acetaldehyde.

The overflow from the reactor is cooled and pressured to the vinyl chloride column which operates at a pressure such that overhead product can be condensed by chilled water. The product vinyl chloride monomer is stored in pressure tanks at low temperature.

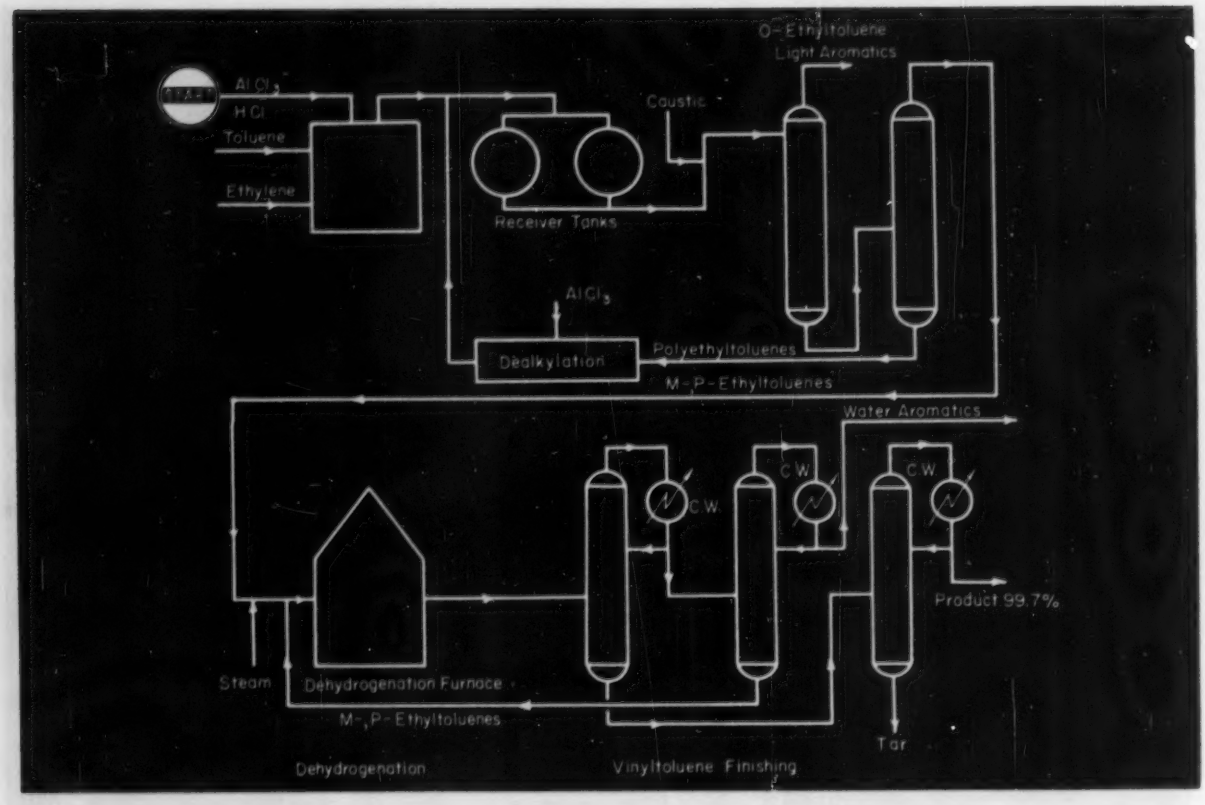
The bottoms stream from the vinyl chloride tower passes to another still where a water-ethylene dichloride azeotrope is carried overhead. Water is decanted and the dichloride is recycled to process. The bottoms stream from this final still contains high boilers, salt, and water, and is discarded.

Yields: Over-all process yield, vinyl chloride from chlorine or ethylene: 90 percent.

Commercial Installations: This process or a variation is used at the following plants: Carbide and Carbon Chemicals Company, Texas City, Texas; Monsanto Chemical Company, Texas City, Texas; Dow Chemical Company, Freeport, Texas, Midland, Mich.; Diamond Alkali Company, Deer Park, Texas.



VINYL CHLORIDE
(ETHYLENE AND CHLORINE)



Vinyltoluene

Application: A process for the manufacture of mixed m-, p-vinyltoluene.

Charge: Toluene, ethylene, aluminum chloride, and hydrochloric acid or ethyl chloride.

Products: High purity mixed m-, p-vinyltoluenes, o-ethyltoluene, small amounts of other coproducts.

Description: Toluene is alkylated by high purity ethylene using anhydrous $AlCl_3$ and HCl as catalyst. The ethylene is bubbled through the toluene-catalyst mixture and the crude reaction mixture overflows to receiving tanks and is neutralized by caustic contact. The neutralized crude alkylate is continuously fractionated to recover the various aromatics: benzene, toluene, ethylbenzene, xylenes; o-, m-, and p-ethyltoluenes; and polyethyltoluenes. The polyethyltoluenes are dealkylated by reaction with toluene and an $AlCl_3$ catalyst, and the resulting ethyltoluenes are then fed to the distillation system. The o-ethyltoluene is separated from the m- and p-ethyltoluenes by precise fractionation, since its presence is detrimental to the dehydrogenation following.

The mixed m- and p-ethyltoluenes are diluted 3:1 with steam and the hydrocarbon-steam mixture then passed over a dehydrogenation catalyst at 580 to 625 C. The steam reduces by-product make and continuously regenerates the catalyst by the water-gas reaction.

The crude dehydrogenated mixture is finished by continuous fractionation in three steps as shown below:

VINYLTOLUENE FINISHING

Step	Distillate	Residue
1	Benzene, toluene, xylenes, ethylbenzene, styrene, m- and p-ethyltoluenes	m- and p-vinyltoluenes and tar
2	Benzene, toluene, xylenes, ethylbenzene, and styrene	m- and p-ethyltoluenes
3	m- and p-vinyltoluenes	Tar

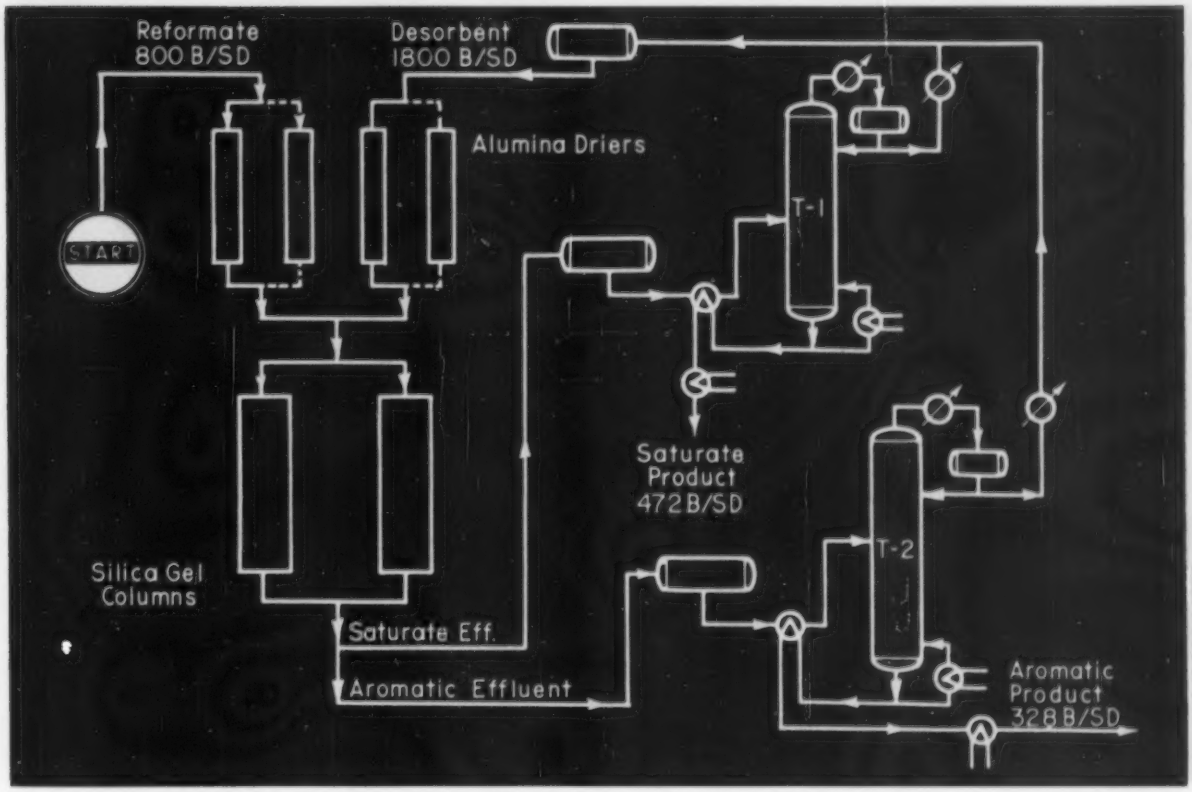
The fractionations are conducted at reduced pressures ranging from 15mm to 140mm. mercury absolute. The purified mixed vinyltoluenes are inhibited and stored in the same way as styrene.

Operating Conditions: Critical items in the process are: (1) the need for precise fractionation of the ethyltoluene alkylate for removal of the ortho isomer, since the total boiling point spread is only 3.1 C.; and (2) the use of steam as a diluent in the dehydrogenation to reduce the byproduct formation.

Yields: Actual yields are not available, but are commercially satisfactory.

Commercial Installation: This process is used commercially by Dow Chemical Co., Midland, Mich.

Reference: Boundy, R. H., and R. F. Boyer (Eds). Styrene: Its Polymers, Copolymers, and Derivatives. A.C.S. Monograph No. 115. New York, Reinhold Publishing Co., 1952, Chapter 17.



Arosorb

SUN OIL COMPANY

Application: The process is primarily for the separation of aromatics from various refinery streams.

Charge: The Arosorb unit shown is in actual operation and processes a 250-400 F. cut of catalytic reformate. However, the aromatics from almost any available refinery stream boiling 150-700 F. may be separated by this process.

Products: These can include aromatic and paraffinic solvents of varying boiling ranges, high octane gasoline components, and high cetane number diesel fuels. The process will also produce high purity benzene, toluene, and xylenes when used with fractional distillation.

Description: The stream quantities and the method of operation apply specifically to the processing of 800 barrels per stream day of catalytic reformate. The desorbent consists of benzene diluted with about 40 percent of a 160-190 F. saturate fraction. The charge and desorbent are passed over activated alumina driers which will remove water and other gel poisons. After pretreatment the charge flows through the two gel columns where the charge aromatics are absorbed displacing the desorbent aromatics left from the previous cycle. The desorbent then follows desorbing the charge aromatics with desorbent aromatics to complete this cycle.

The effluent from each cycle is divided into two parts. The first portion containing the saturates goes to fractionator T-1 where the saturate product is removed as bottoms and the desorbent distilled overhead. The second portion, containing the charge aromatics, flows to T-2 where the aromatic product is withdrawn as bottoms and the desorbent is taken overhead. The desorbent streams are combined for re-use.

Modifications in this process include use of a desorbent boiling higher than the charge, dilution of viscous charge stocks, and the recycling of a portion of the effluent for high purity operation.

Operating Conditions: The adsorption columns are usually operated at atmospheric temperatures. However, if a reduction in viscosity is desirable, the column may be operated at temperatures up to 150 F. The columns are rated at a pressure of 150 psi.

Yields: Typical operating data are given below for two plants, the first charging 250-400 F. catalytic reformate and the second charging kerosine.

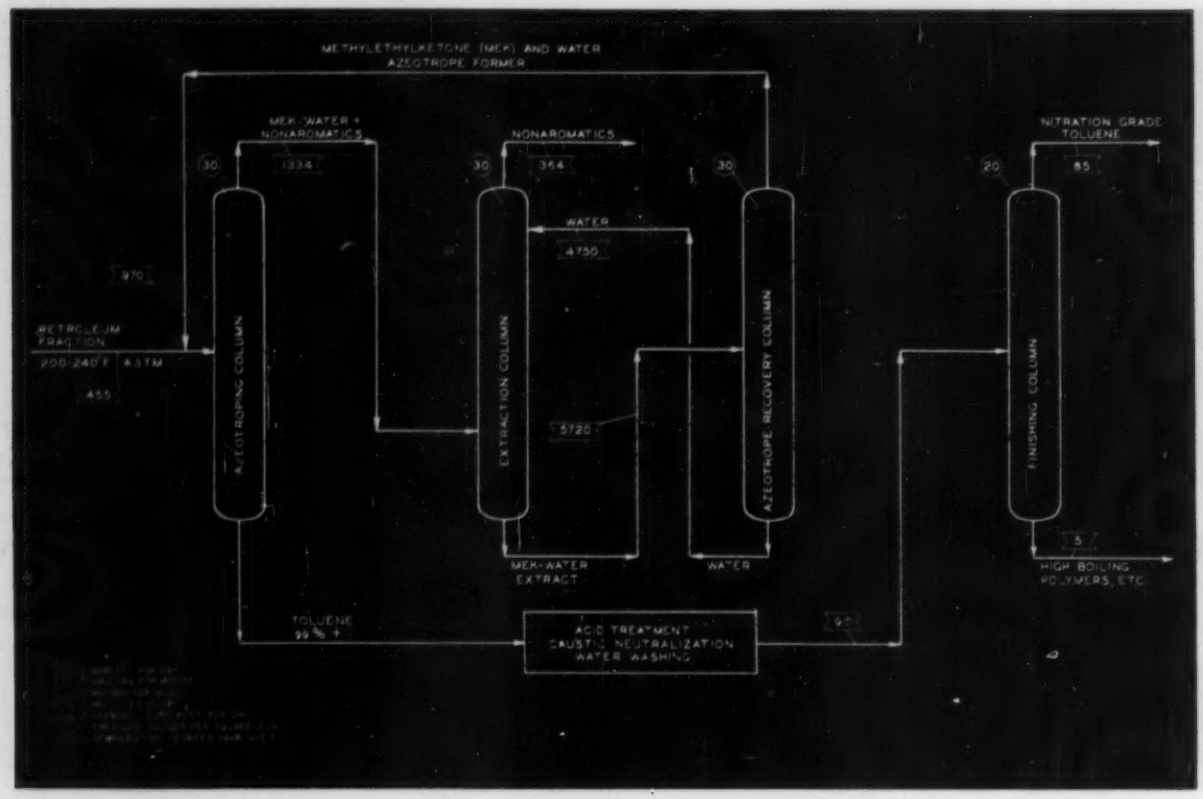
250-400 F CATALYTIC REFORMATE

	Charge Stock	Aromatic Conc.	Saturate Conc.
Yield	100	59	41
Volume Percent Aromatics	63	93	19
Volume Percent Saturates	37	7	81

	Kerosine* Charge Stock	Aromatic Conc.	Saturate Conc.
Yield	100	16	84
Volume Percent Aromatics	16	91	1
Volume Percent Saturates	84	9	99
Gravity, °API/60 F	43.3	24.4	47.0

* Davis, W. H., Harper, J. L., and Weatherly, E. R., "The Arosorb Process in Refinery Operations," 17th Mid-Year Meeting API, May 14, 1952.

Reference: PETROLEUM REFINER, May'52,p100.



Azeotropic Fractionation

THE UNION OIL COMPANY

Application: The process has been used successfully for the production of high purity toluene from catalytic reformates and virgin naphthas. This process also can be used for the production of high purity benzene and xylene from petroleum fractions.

Charge: The charge stock for this process is the appropriate boiling range distillate containing either benzene, toluene or xylene. It may be either a virgin or cracked naphtha or the product derived from a catalytic reforming operation. The process shown in the flow diagram uses an aromatic cut from a catalytic reformer that has been previously split into benzene, toluene, and xylene concentrates. The toluene concentrate is charged to this process.

Product. Nitration-grade benzene, nitration-grade toluene or 95 percent plus xylene fraction can be produced.

Description: The principle of azeotropic fractionation is used to separate materials having similar boiling points. An azeotropic former is used to change the boiling point of a portion of the original mixture; thus, a separation can be effected between two portions of a mixture by simple fractionation.

A flow diagram illustrating this principle is shown above. In this case, a mixture of methyl ethyl ketone and water is used as the azeotrope former. Major production of nitration-grade toluene has been carried out by this process.

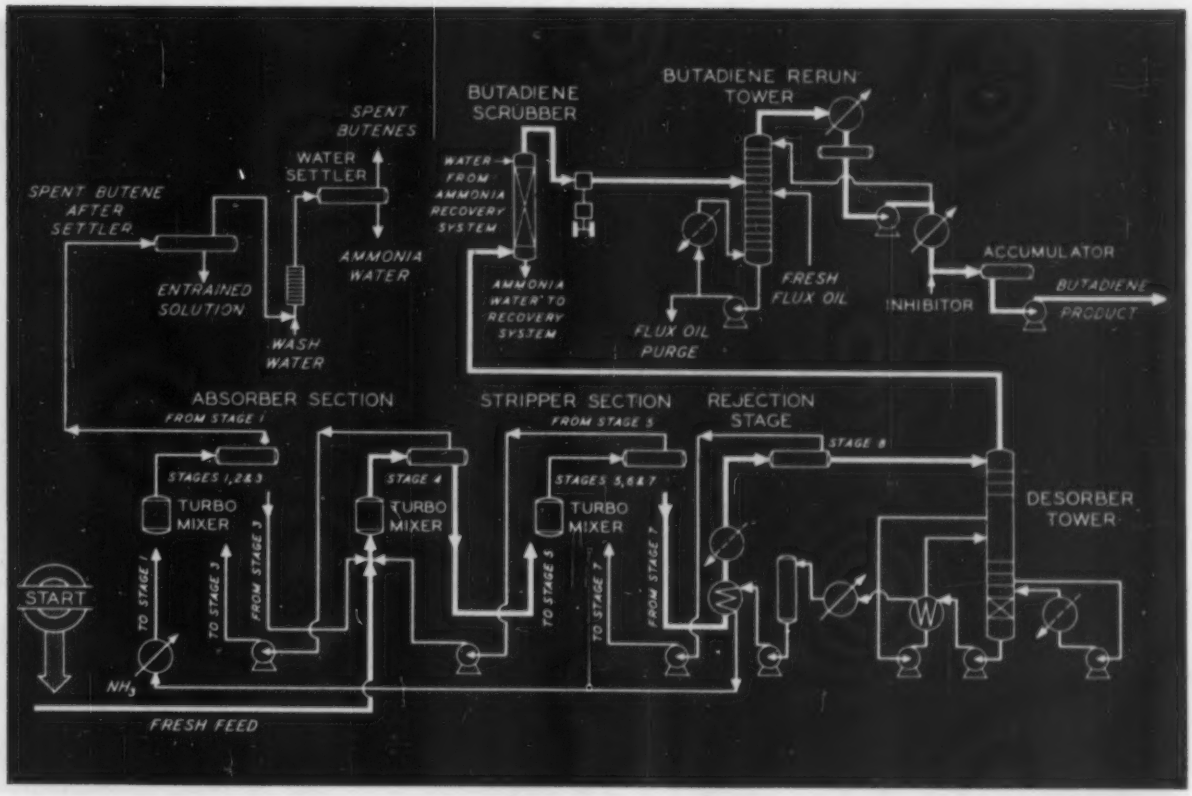
The azeotrope former is added to the azeotropic distillation column with the toluene-containing fraction. A constant boiling mixture of non-aromatic hydrocarbons, water and methyl ethyl ketone passes overhead, giving a bottom product of substantially pure toluene. To meet the specifications for nitration-grade toluene, a slight acid treat is used. The toluene is then caustic neutralized and water washed before being rerun in a finishing column.

The overhead from the azeotropic column, containing the non-aromatics water and the methyl ethyl ketone, is fed to the extraction column. The non-aromatics are removed overhead while the methyl ethyl ketone is extracted with water and goes out the bottom of the column. This stream is then fed to the azeotrope recovery column where the methyl ethyl ketone-water mixture used as the azeotrope former is recovered and recycled to the azeotroping column. Water from the bottom of the recovery column is recycled directly to the extraction column.

Operating Conditions: In the recovery of toluene by the Azeotropic Fractionation process, a 2.5 to 1.0 ratio of methyl ethyl ketone to non-aromatic fraction is charged to the azeotropic distillation column. Other major operating conditions are indicated on the flow sheet.

Yields: Commercial yields have shown an over-all recovery in the range of 95 to 98 percent.

Commercial Installations: One unit at the Oleum Refinery of the Union Oil Company operated successfully throughout the war period producing nitration-grade toluene.



Butadiene Extraction

ESSO RESEARCH AND ENGINEERING CO.

Application: A liquid phase selective solvent extraction process for recovering butadiene.

Charge: A butane-butene-butadiene cut produced by catalytic dehydrogenation of normal butenes or by high temperature cracking of naphtha or gas oil.

Product: Butadiene of 98.5+ percent purity.

Description: The three major components of the charge stream, butadiene, butanes and n-butenes, have close boiling points and it is necessary to use a solvent which will selectively absorb the butadiene. The solvent used is an aqueous ammoniacal cuprous acetate solution of this approximate composition:

	Mols/Liter	Weight Percent
Total Copper	3.3	17.5
Cuprous Copper	3.0	
Acetate (Acetic Acid)	4.0	20.0
Ammonia	11.0	15.5
Water	31.3	46.9
	....	100.0

In the absorber section, the stripper section and the rejection stage, the butadiene is contacted and absorbed by the solvent while the majority of the butanes and butenes are rejected from the system. The solvent is mixed with the hydrocarbon feed in a series of stages, each of which consists of a turbo mixer and a settler. The hydrocarbon not absorbed by the solvent is recycled back to other stages for additional contacting with the solvent until essentially all the butadiene is finally absorbed. The hydrocarbons that are rejected are water washed and then are recycled to the catalytic rehydrogenation plant or are diverted to alkylation plant feed.

The solvent containing the butadiene is fed to the desorber tower where the hydrocarbon stream is separated from the solvent. The hydrocarbon stream is sent to the butadiene scrubber where water washing removes solvent.

From the scrubber the butadiene stream goes to the butadiene rerun tower where enough of the other components are removed to bring the stream up to 98.5+ percent purity butadiene. This tower uses a flux oil to make the separation. After the addition of an inhibitor, the final product is sent to storage.

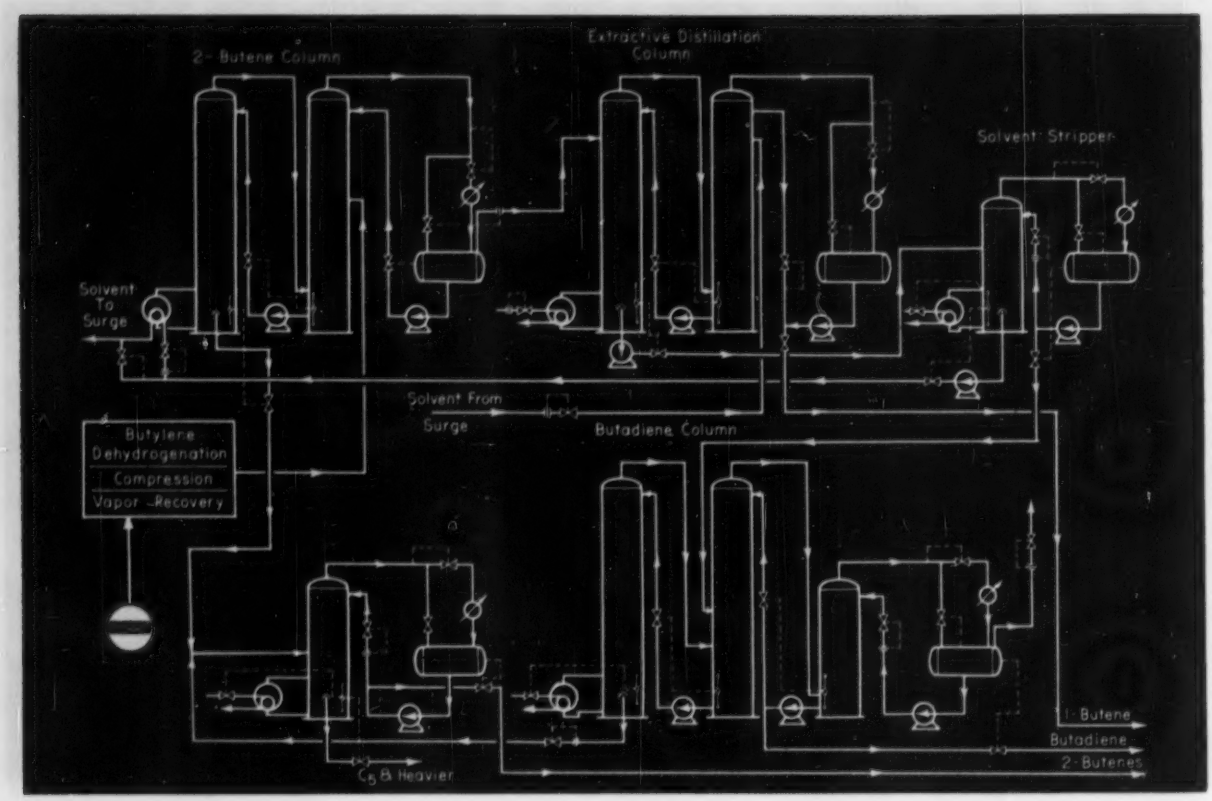
Operating Conditions: The principal operating conditions are:

Ratio of Copper solution to Feed, lb./lb.	8.0
Lean Solution Temperature, F	8
Lean Solution Pressure, psig	45
Rejection Temperature, F	100
Desorber Bottom Temperature, F	175
Desorber Bottom Pressure, psig	15

Yields: Typical yields and analyses of the feed and products are as follows:

	Feed Mol. Percent	Spent Butenes Product, Mol. Percent	Butadiene Product, Mol. Percent
C_3	0.2	0.3	0.3
Butadiene	16.7	0.9	98.5 (Min.)
i-Butene	4.9	5.7	0.2
n-Butenes	62.8	75.1	1.0
Butanes	15.3	17.9	.....
C_5	0.1	0.1	.....
	100.0	100.0	100.0

Butadiene Recovery (percent of butadiene in feed)—95 percent.



Butadiene Extraction (Furfural)

PHILLIPS PETROLEUM CO.

Application: A process to recover butadiene from a stream of mixed hydrocarbons.

Charge: A depropanized C_4 fraction from a dehydrogenation or cracking operation.

Product: Polymerization grade butadiene of a minimum purity of 98 weight percent.

Description: The material from which butadiene is to be recovered is subjected to prefractionation to remove propane and lighter components from the feed before extractions. The propane and butane recovered is returned to the battery limits and sold as LPG or it may be consumed as fuel. Certain plants recycle the recovered butane to the butane dehydrogenation section of the butadiene plant where it is catalytically converted to butadiene. This is a continuous process and is described in detail in this handbook under the heading "Butadiene from Butane."

The depropanized feed stream containing all seven C_4 isomers enters the butene-2 column where the butadiene fraction is concentrated. The reboiler product contains most of the high boiling butene-2, as well as part of the low-boiling butene-2 and C_4 acetylenes. Part of the normal butane goes overhead and part goes out with the kettle product.

The overhead from the butene-2 column is charged to the extractive distillation column. This column acts as an absorber, preferentially absorbing butadiene and small amounts of the other C_4 unsaturates.

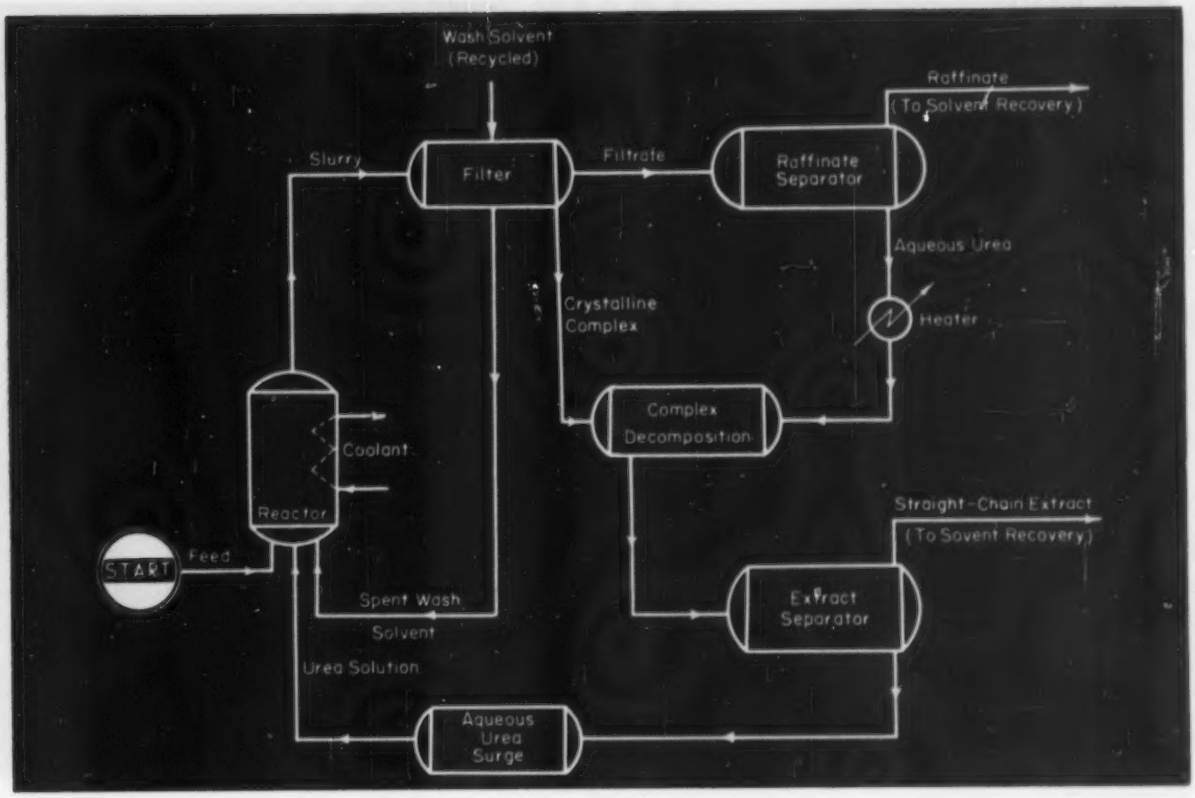
The rich solvent leaving the bottom of the extractive distillation column is pumped to a stripping column where the hydrocarbons (butadiene, butenes-2, and traces of other C_4 hydrocarbons) are stripped from the solvent and sent to the final separation step (the butadiene column). In the butadiene column, butenes-2 and C_4 acetylenes are removed as a reboiler product and butadiene of a minimum purity of 98 weight percent is yielded as a side draw near the top of the column.

Although the present principal use for butadiene is synthetic rubber, it is rapidly becoming known as a chemical intermediate. Butadiene is now considered as a raw material for nylon manufacture and other new uses are being developed daily.

TYPICAL ANALYSES OF FURFURAL EXTRACTIVE DISTILLATION SYSTEM (MOLE PERCENT)

COMPONENT	Extractive Distn. Column		Furfural Stripper
	Feed	Overhead Product	Overhead Product
Isobutane	5.8	8.3	....
Isobutylene	6.8	9.8	....
Butene-1	29.8	42.8	....
Butadiene	26.2	1.2	83.8
n-Butane	15.1	21.6	....
Butene-2 (low boiling isomer)	13.0	14.6	9.2
Butene-2 (high boiling isomer)	3.3	1.7	7.0
	100.0	100.0	100.0

Commercial Installations: About 66 percent of all the butadiene produced in the U. S. is recovered by furfural extractive distillation.



Extractive Crystallization with Urea

Application: A process for the separation of straight-chain components from a mixture of hydrocarbons.

Charge: The charge is a liquid hydrocarbon fraction, a saturated aqueous urea solution, and a hydrocarbon-soluble solvent.

Products: The products are (1) a straight-chain extract, and (2) a raffinate which represents that portion of the feed which did not form a crystalline complex with urea.

Description: Urea forms crystalline complexes with straight-chain compounds but does not form such complexes with most branched-chain and ring-type compounds. The reaction is dependent largely upon the shape and dimensions of the potential reactant molecules.

The initial step in the process involves the reaction of urea and the straight-chain hydrocarbon to form a crystalline complex. This reaction may occur with solid urea that has been mixed with the feed, or by intimately mixing the feed with a saturated aqueous or methanolic solution of urea. An auxiliary hydrocarbon-soluble solvent, such as methylisobutyl ketone is usually added when saturated aqueous urea is used. This serves to increase the reaction rate and provides a suitable wash for the crystalline complex in the separation step.

The use of a saturated aqueous urea solution is shown in the flow diagram. A typical feed contains about 15 percent n-paraffins. The feed, saturated aqueous urea solution and solvent enter the reactor at a temperature in the range of 90 to 100 F. Cooling is provided to remove the heat of reaction and maintain saturation of the urea solution. There is a 15 to 20 F. reduction in temperature across the reactor. The slurry is filtered and washed with the solvent to remove occluded raffinate, and the filtrate is sent to a vessel for separation of the aqueous and hydrocarbon raffinate phases. The aqueous phase is then heated sufficiently to raise the temperature in the decomposition vessel to 40 to 60 F. above the reactor outlet temperature. This increased temperature shifts the solubility-stability relationship between the aqueous urea and the crystalline complex toward decomposition of the complex. The urea goes into the aqueous phase, and the extract separates as an insoluble liquid phase that is recovered in the extract separator. The aqueous urea solution is recycled to the reactor after adjustment to the desired reactor inlet temperature.

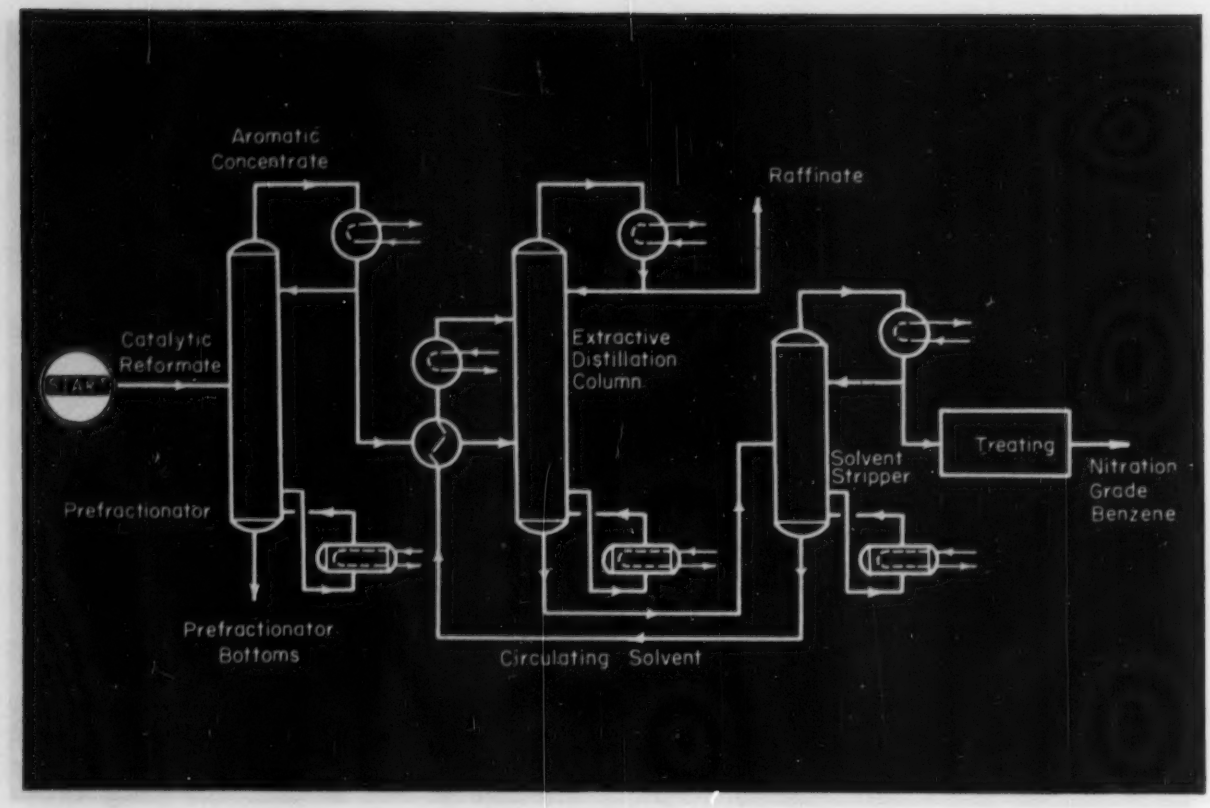
Operating Conditions: For high reaction efficiency the urea solution is maintained saturated by temperature control. Example conditions for a heavy distillate fraction (12 volume percent n-paraffin).

Bbl. Urea solution/Bbl. feed	3
Bbl. Solvent/Bbl. feed	1
Reactor inlet temperature, F	95
Reactor outlet temperature, F	80
Decomposition temperature, F	140
Reactor residence time, minutes	15
Pressure	Atmospheric

Yields: 95-99 percent purity n-paraffins from non-olefinic feeds.

Commercial Installations: There are at least three commercial applications of the general principles of this process.

Reference: Petroleum Refiner March, May, July, '52; Apr. '55.



Extractive Distillation

SHELL DEVELOPMENT COMPANY

Application: The process has been used successfully for recovering nitration grade benzene, toluene, or xylene from appropriate petroleum fractions.

Product: The product has a purity of 98 to 99 percent and is satisfactory for most uses; however, acid treating and redistillation may be necessary to meet nitration specifications.

Description: The separation of aromatics from non-aromatic is accomplished by distillation of the petroleum fraction in the presence of an extractive solvent which has selective solvency for the aromatic and thus reduces its volatility relative to the non-aromatic components. The solvent usually used in this process is phenol, but in special cases other solvents such as cresylic acids or sulfolanes may be preferable.

The flow diagram illustrates the application of the process to production of nitration grade benzine from a C_6 depentanized catalytic reformate. The original charging stock is first fractionated to prepare an aromatic concentrate.

The extractive distillation column consists of a knock-back section and an extraction section. The aromatic concentrate is charged at a point near the middle of the extraction section, and as in ordinary fractionation, vaporization heat is supplied in a reboiler, and the overhead vapors after condensation are partially returned as reflux to the column. The top product contains essentially all the non-aromatics including the olefins and diolefins and only a trace of solvent. The bottom product is a mixture of the aromatic and solvent. The constituents are separated in the solvent stripping column. The aromatic is distilled off as top product, and the solvent is recycled to the extractive distillation.

The loss of aromatic in the raffinate from the extractive distillation column need not exceed one percent of the raffinate stream. Loss of solvent is small; other than by mechanical leakage, solvent is lost through upset operation of the knock-back section in the extractive distillation column and of the stripping column.

Yields: The table shows a material balance (solvent-free basis) for producing nitration grade benzene from depentanized catalytically reformed C_6 naphtha.

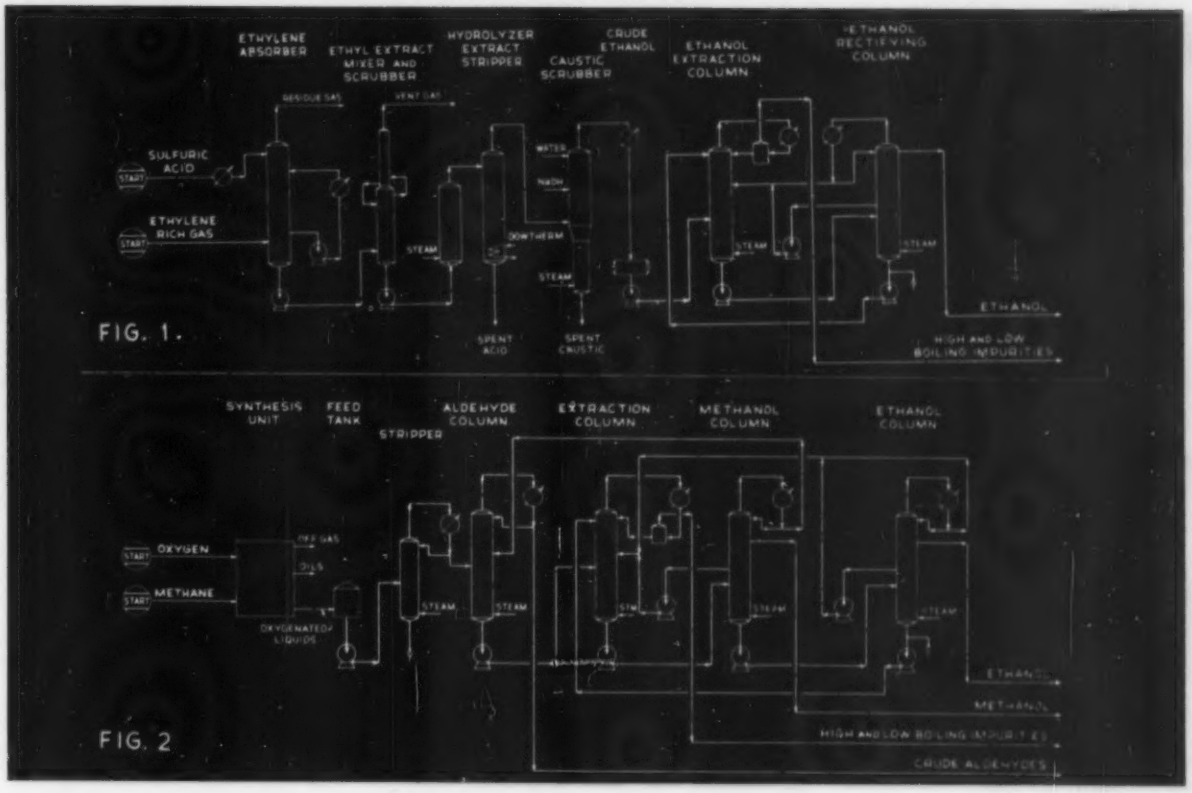
	Feed		Top Product		Bottom Product	
	Bbl./sd.	%v Benzene	Bbl./sd.	%v Benzene	Bbl./sd.	%v Benzene
Benzene Concentration	2214	45.9	2004	50.5	210	2.0
Extractive Distillation	2004	50.5	994	1.0	1010	99.2
Solvent Stripping	1010	99.2	1010	99.2	Solvent	
Redistillation*	1010	99.2	1000	99.5	10	....

* After acid treatment and caustic wash.

Commercial Installations: The table below lists the units now operating.

COMPANY	LOCATION	AROMATIC
I. Now Operating:		
1. Continental Oil Company	Ponca City, Oklahoma	Benzene, toluene
2. Pan American Refining Corporation	Texas City, Texas	Benzene
3. The Pure Oil Company	Toledo, Ohio	Toluene
4. Shell Oil Company	Wilmington, Calif.	Benzene, toluene and xylenes
5. Shell Oil Company	Wood River, Illinois	Toluene, cylenes
6. Standard Oil Company (Indiana)	Whiting, Indiana	Benzene
7. Atlas Oil Processing Company	Shreveport, Louisiana	Benzene
8. Shell Oil Company	Houston, Texas	Benzene, toluene
9. Standard Oil Company of California	El Segundo, Calif.	Benzene

Reference: PETROLEUM REFINER, Sept.'52,p242.



Extractive Distillation of Alcohols

STONE & WEBSTER-BADGER

Application: A process for recovery and purification of high purity alcohol.

Charge: Hydrocarbon oxidation products may be processed to recover essentially all of their alcohol content.

Product: High-grade industrial alcohols or neutral spirits meeting rigid chemical and organoleptic specifications.

Description: Ethanol produced from ethylene by the sulfation and subsequent hydration (as shown in Figure 1) is relatively pure and may be finished in a conventional two-column system.

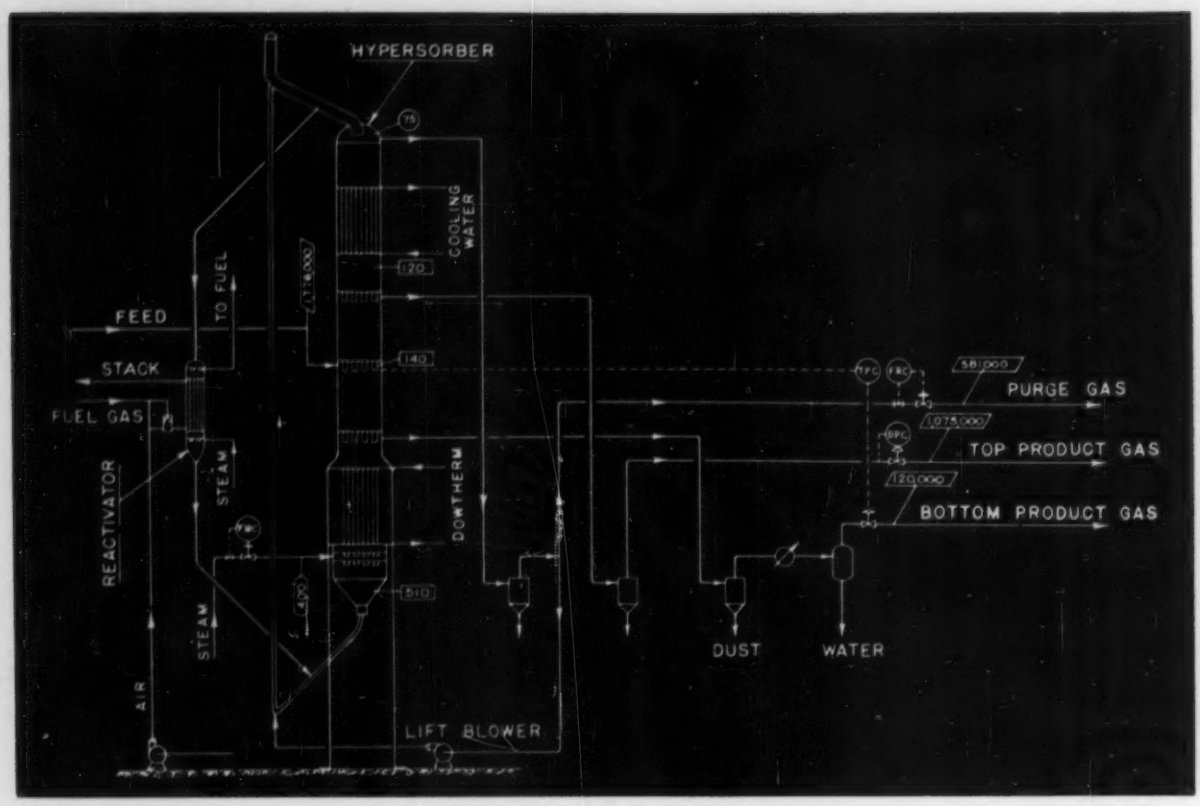
In Figure 1, the extractive distillation method is shown. Crude ethanol is fed into the mid-portion of the extraction column. Sufficient water is added to the top plate of the column to give a low proof bottoms and live steam is added to the base. As the vapor ascends the stripping section of the column, all of the volatile compounds tend to be stripped out of the descending low ethanol concentration liquid; however, at this low ethanol concentration, both the low and high boiling impurities have higher volatility and are preferentially removed upwards. The vapors above the feed plate are washed with large quantities of water, such that the more soluble ethanol is absorbed and returned to the stripping section, eventually flowing out the bottom. The overhead vapors, consisting essentially of impurities and water, are condensed and returned to the top plate as reflux. The impurities, substantially free of ethanol, are drawn off from this reflux stream as the overhead product from the column.

The dilute bottoms from the extraction column are fed to the rectifying column where the ethanol is withdrawn as a pasteurized product near the top. A heads cut from the top and a high boiler recycle stream near the feed plate are returned to the dilute zone of the extraction column above the feed point. Water, free of ethanol, flows from the base of the column and is recycled back as dilution water to the extraction column. Substantially all of the ethanol contained in the feed is recovered as high-grade neutral spirits of superior quality to those produced by a unit employing conventional heads and concentration columns.

Figure 2 illustrates a unit that will recover ethanol from a mixture of oxygenated compounds, which are present in processes of partial oxidation of light aliphatic hydrocarbons, either for the purpose of producing synthetic fuels or organic chemicals as such. A crude distillate of this nature must be processed by extractive distillation if complicated and expensive chemical treatment is to be avoided.

The water layer effluent from the reaction is first passed through a stripper to concentrate partially the chemicals and to remove acidic impurities. The acid-free feed is then fed to an aldehyde column for the removal of acetaldehyde and other low boiling impurities before entering the extraction column. If there is a considerable quantity of methanol present in relation to the ethanol, the two alcohols may be purified together and separated from each other after the extraction step in two separate columns, as indicated in Figure 2. However, if the amount of methanol is small in relation to the ethanol content, the aldehyde column may be operated to take methanol and lighter compounds overhead, and the methanol column can be eliminated. The operation of the extraction column is the same as in the system shown in Figure 1 and high quality methanol and ethanol are produced.

Commercial installations: Numerous installations are in operation refining not only distillates from ethylene hydration and oil synthesis plants but also from fermentation processes.



Hypersorption

THE UNION OIL COMPANY

Application: Hypersorption is used for the separation of volatile hydrocarbons and other gaseous compounds. It is particularly applicable to the recovery and production of pure hydrogen, methane, acetylene, ethylene, and propylene.

Charge: The charge for this process is a gas stream which may be derived from natural gas operations, high temperature cracking operations on either liquid or gaseous hydrocarbons, or steam-methane reforming operations for the production of hydrogen.

Description: Feed gas entering through a distributor passes upward counter-current to the moving bed of activated charcoal. In its passage through the bed, the heavier compounds are adsorbed and retained on the charcoal. The top product gas, comprising the lightest constituents in the feed, disengages from the charcoal below the cooler and passes off through a cyclone. The charcoal passes downward below the feed point to the rectifying section where it contacts a reflux of heavy constituents, separated in the stripper which serves to liberate lighter constituents adsorbed on the downward-moving charcoal. A concentration of these latter constitutents in the vapor phase results and if desired they can be disengaged as a side-cut product gas at a point between the feed and bottom product gas disengaging sections. As the charcoal flows past the bottom product gas disengaging section into the steaming section, it meets an upward flow of steam which liberates the adsorbed heavy components, and these flow upward either to return as reflux or pass out as bottom product gas from the Hypersorber.

The charcoal flows from the steaming section into the stripping section wherein it passes down through tubes which are heated by a circulating heat-transfer medium and through which steam is passed counter-current to the charcoal. The hottest point in the stripper is at the bottom of this section and substantially all residual adsorbed material is removed during the passage of the charcoal through this zone.

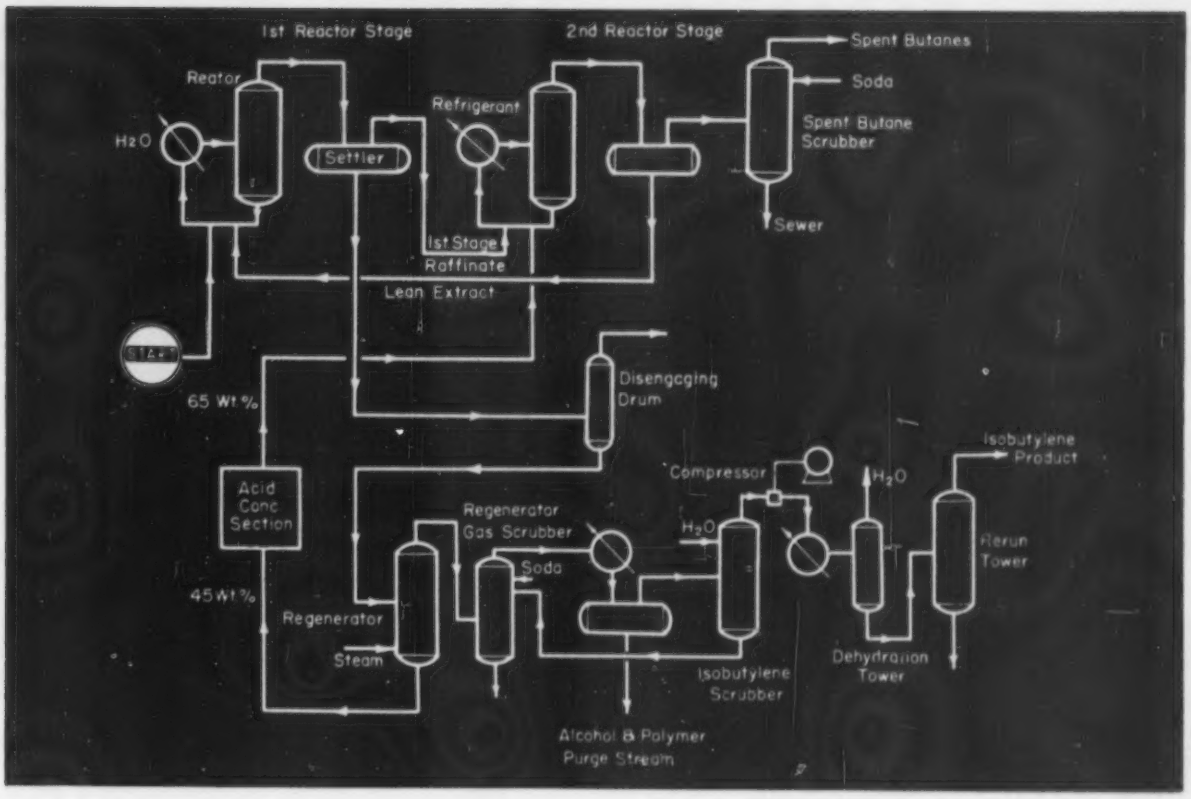
A charcoal regeneration unit, acting in parallel with the Hypersorber, carries out high temperature steam treatment of the charcoal to maintain its activity.

The charcoal is transported to the top of the tower by a gas lift system and is dropped into the reserve charcoal hopper at the top of the unit. The hot charcoal passes down from the hopper into the cooling section consisting of a tube and shell exchange wherein the charcoal is cooled to the desired temperature for adsorption.

Yields: The application of Hypersorption in the recovery of ethylene from a lean gas stream is shown, and the yields in a typical commercial operation are given in the table below.

Comp.	Feed Gas, Volume Percent	Bottoms Product, Volume Percent	Overhead Product, Volume Percent	Purge Gas, Volume Percent
Hydrogen	39.8	....	31.6	61.8
Nitrogen	1.7	....	1.4	2.5
Carbon Monoxide	0.9	....	0.8	1.3
Oxygen	0.1	0.1	0.1	0.2
Methane	51.3	....	66.1	33.7
Carbon Dioxide	0.2	2.9	....	0.1
Acetylene	0.2	3.6	....	....
Ethylene	5.8	92.7	....	0.4
Ethane	Trace	0.7	....	....
Total	100.0	100.0	100.0	100.0

Reference: PETROLEUM REFINER, Oct.'54,p153.



Isobutylene Extraction

ESSO RESEARCH AND ENGINEERING CO.

Application: A process for the extraction of isobutylene.

Charge: A stream containing 10 to 35 weight percent isobutylene, mixed with n-butylenes and varying amounts of saturated hydrocarbons.

Product: The product is 99+ percent purity isobutylene.

Description: The feed is charged to a two stage reactor-settler where it is contacted with 65 percent sulfuric acid. Maintaining the proper acid strength for the reactor section is important so that the acid does not absorb the other feed components to any appreciable extent. Isobutylene is selectively extracted in accordance with the following hydration reaction:

$$H_2O + \text{i-}C_4H_8 \overset{H_2SO_4}{\rightleftarrows} \text{t-}C_4H_9OH$$

This reaction is highly exothermic and the temperature within the second stage reactor must be closely controlled by refrigeration to prevent excessive absorption of the other components.

The spent butanes are removed from the second stage settler and treated for other petrochemical or refinery uses. The isobutylene-acid extract is removed from the first stage settler and sent to the regenerator.

In the regenerator the isobutylene is stripped from the acid with steam. The acid, which has become diluted in the process, goes to a concentrator where its strength is built back up to 65 percent for recycle to the reactor section.

The regenerated isobutylene from the steam stripping operation is washed with caustic to remove traces of acidic impurities and to hydrolyze and then neutralize any esters that were formed in the process. Caustic washing is followed by water washing to remove any excess caustic.

Isobutylene from the water washing step is fed to a fractionator where the high-boiling materials formed in the process are removed. The purified isobutylene is then compressed, condensed and delivered to storage.

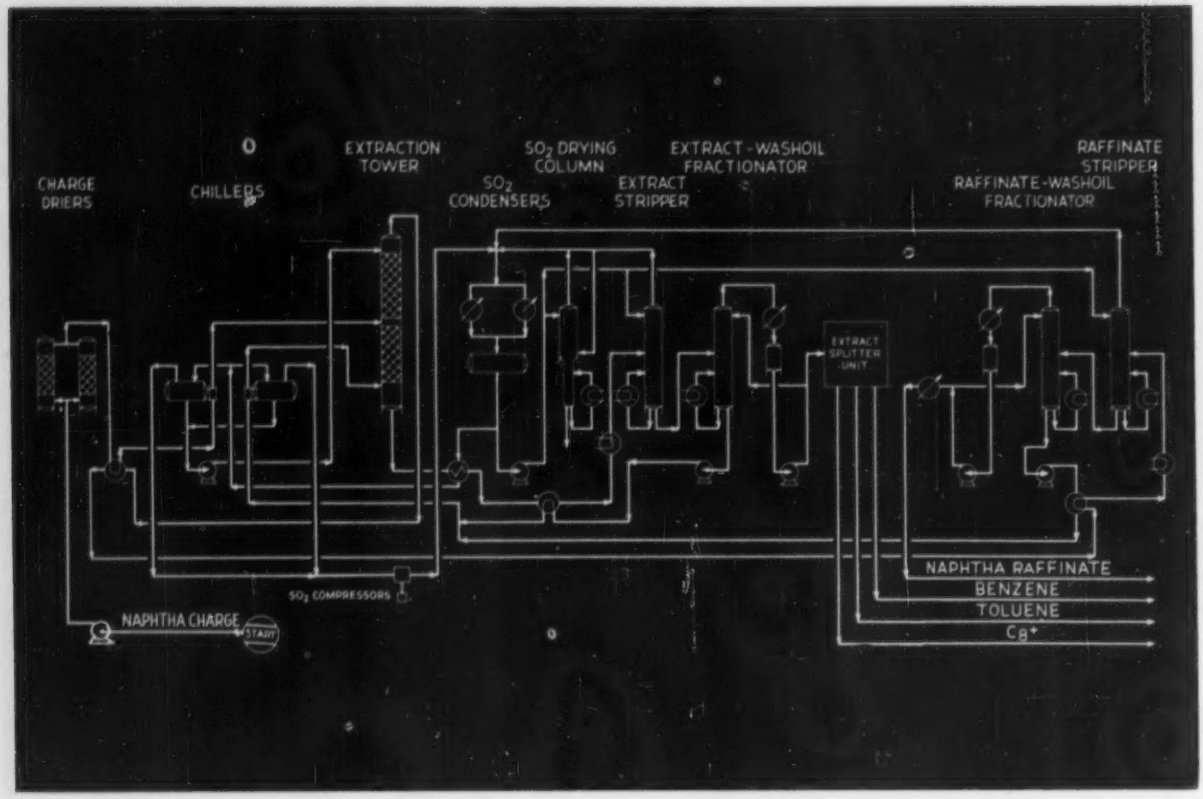
Operating Conditions: The major operating conditions are as follows:

Acid concentration for isobutylene extraction	65 percent
Dilute acid concentration from regenerator	45 percent
Lean extract, approximate saturation, mol $iC_4^=$/mol H_2SO_4	0.5 percent
Rich extract, approximate saturation, mol $iC_4^=$/mol H_2SO_4	1.5 percent
Recovery of isobutylene from feed	85 percent

Yields: Typical yields and analyses of the feed and products are as follows:

	Feed LV%	Spent Butanes LV%	Isobutylene Product LV%
Propene-propylene	2.0	2.3	—
n-butenes	28.0	31.9	0.4
Isobutylene	14.0	1.2	99.4
n-butane	23.0	26.1	0.1
i-butane	31.0	35.3	—
C_6+	2.0	3.2	0.1

Reference: PETROLEUM REFINER, May,'54,p156.



Modified SO_2 Extraction

STONE & WEBSTER-BADGER

Application: This process is applicable to the recovery of pure or highly concentrated aromatics from selected virgin naphthas, catalytic reformates, and heavier petroleum distillates.

Charge: Charge stock for this process can be any selected virgin naphtha containing aromatics, a reformate stream from a catalytic reforming unit, or a gas oil stream containing aromatics.

Products: In the processing of total reformates or of wide range virgin naphtha fractions, the process will simultaneously produce a highly concentrated benzene cut suitable for many industrial applications, nitration-grade toluene and a high-purity xylene and ethyl benzene fraction. If the benzene is to be nitration-grade, the process is supplemented by distillation facilities for final purification of this fraction. Typical purity and recovery of aromatics possible with such a plant are:

Aromatic	Purity	Recovery
Benzene	Nitration grade	98%
Toluene	Nitration grade	98%
C_8 Aromatics	90% plus	95-97%

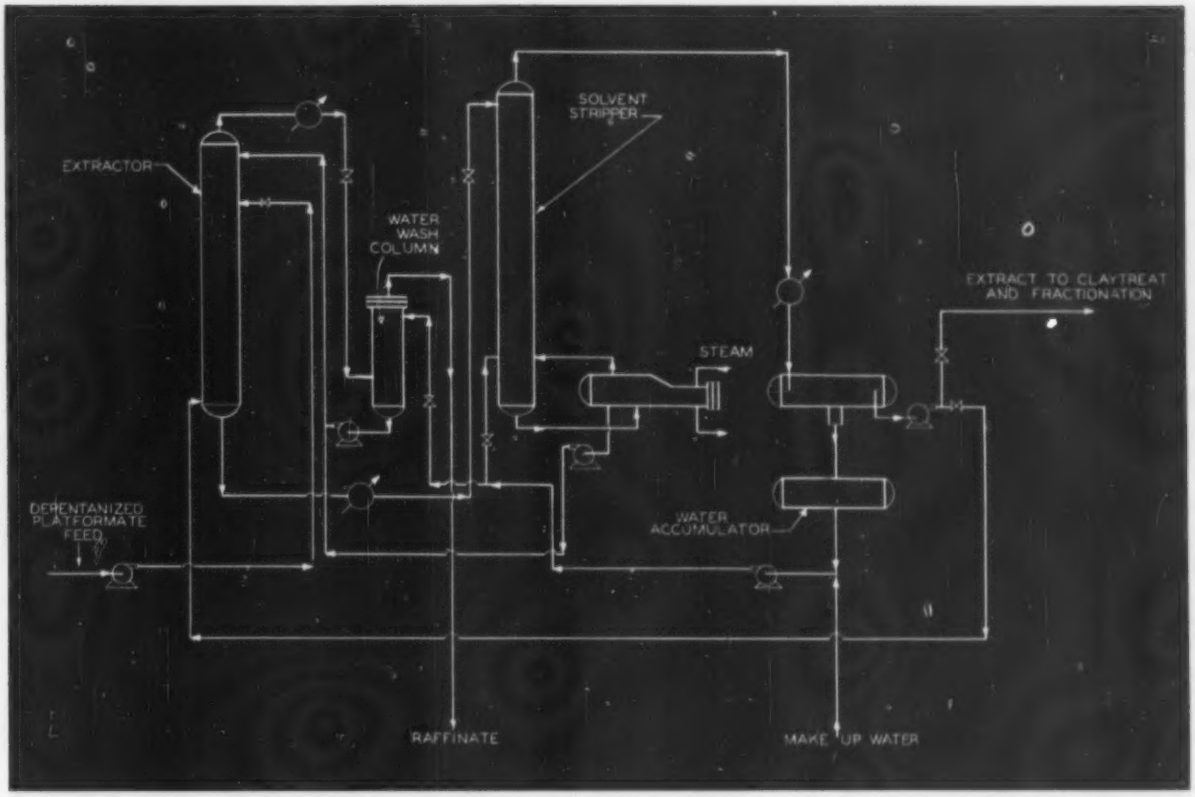
Description: The schematic flow diagram illustrates a plant for the recovery of C_6 to C_8 aromatics from a catalytic reformate. In this plant both the primary extraction of aromatics and the extract stripping are carried out at a temperature of —20 F. The liquid sulfur dioxide used for the extraction serves also as a refrigerant. The primary extraction of aromatics takes place in the upper half of an extraction tower equipped with packing or suitable trays and the extract stripping step is carried out in the lower half of that tower. The stripping agent, herein called wash oil, is a kerosine.

The charge stock, if containing appreciable water, is passed through driers. The charge stock is then chilled by cold SO_2 in a reboiler-type chiller before it is introduced into the center of the extraction tower. Cold liquid SO_2 from the chillers is pumped into the upper section of the extraction tower, while chilled wash oil enters the tower near the base. The contact of the charge stock with SO_2 and the stripping of the extract solution produces a raffinate phase containing the nonaromatic hydrocarbons of the boiling range of the naphtha, the bulk of the wash oil and some SO_2. The extract phase consists largely of aromatics and SO_2 and contains the remainder of the wash oil. The extractor operates under sufficient liquid pressure so that the two phases move to their respective recovery systems without intermediate pumping.

Operating Conditions: For the recovery of C_6 to C_8 aromatics from a reformate, an SO_2 rate of about 170 volume percent based on reformate charge is required. The wash oil rate will be 50 to 75 volume percent.

Commercial Installations: Three installed and two under construction.

References: Petroleum Refiner, Sept.1954,p.230; Petroleum Refiner, May,1954,p.151.



Udex Extraction

UNIVERSAL OIL PRODUCTS COMPANY

Application: The process employs a mixture of glycol and water as a solvent for the separation of high purity aromatics from mixtures with other hydrocarbons.

Charge: The outstanding feature of the process is its ability to handle wide boiling range stocks. The fraction fed to the unit can be as widely boiling as necessary so as to assure inclusion of all of the potential aromatics without interference with the purity of the product, and the difficulties in fractionation which result from non-ideality of mixtures of hydrocarbon types are avoided.

Product: Nitration-grade benzene, nitration-grade toluene, and a xylene-ethylbenzene concentrate of high purity can be obtained as products. Bottoms from the xylene fractionator represent a concentrate of C_9, C_{10}, and C_{11} aromatics.

Description: The process uses an efficient multistage countercurrent extraction column of a novel design developed especially for this purpose. Solvent is fed at the top of the column; hydrocarbon feed, at an intermediate point; and hydrocarbon reflux, at the bottom. The rich solvent is taken to a stripper, wherein the dissolved aromatics are separated from the solvent, the latter being recirculated to the extraction column. Vapors from the stripper are condensed and separated into two phases. The water phase is used in part to wash traces of dissolved glycols from the raffinate; the remainder is returned to the stripper. The hydrocarbon phase from the stripper receiver is a mixture of aromatics from which the benzene, toluene, and a mixed ethylbenzene-xylene fraction—all of high purity—are separated by distillation.

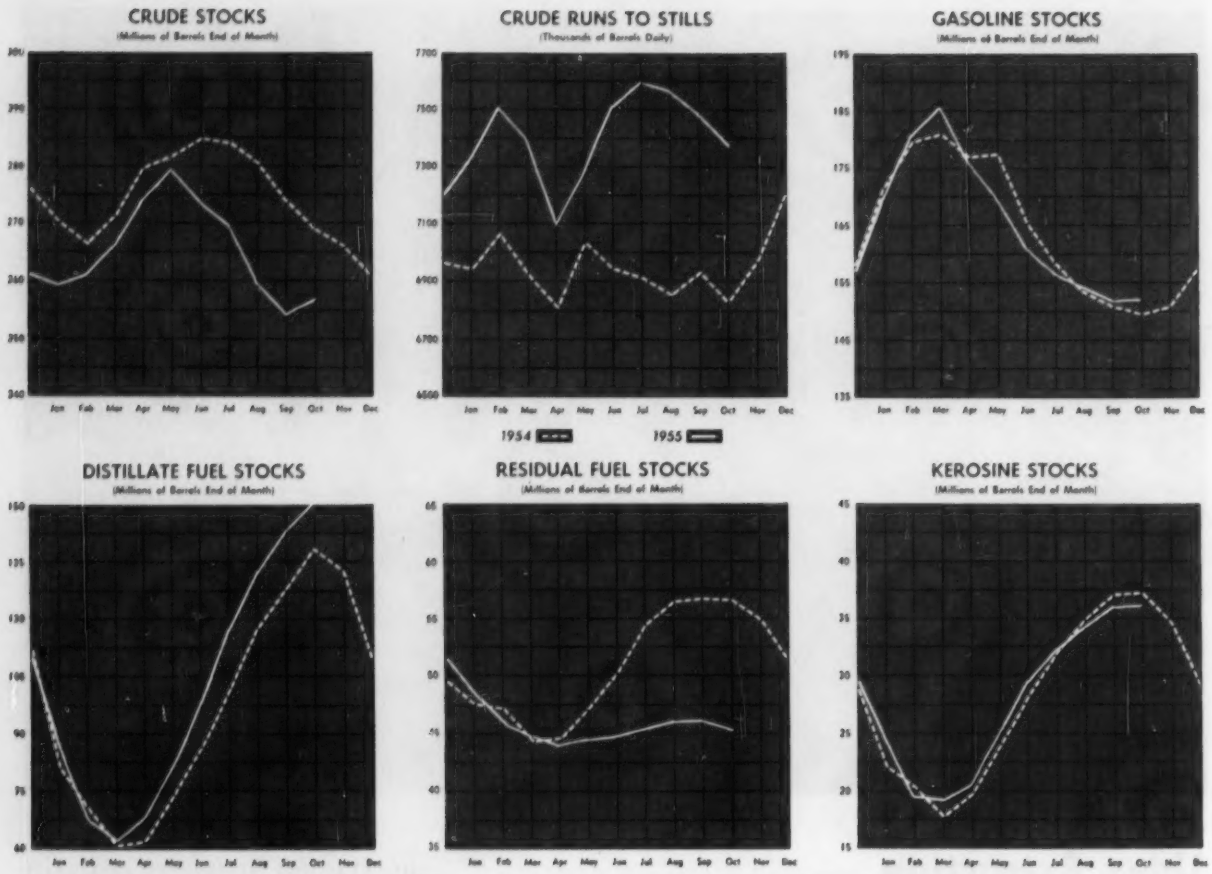
Yields: Yields on UDEX extraction and distillation of typical Platformate are shown in the tables.

Product Properties	Udex Charge	Raffinate	Benzene	Toluene	Mixed Xylenes
Gravity, °API	51.9	76.4			
Specific Gravity, d 20/4	.7715	.6806	.885	.873	.873
Percent Aromatics	51.3	3.5	99.9	99.8	99+
Solidifying Point °C.			5.49		
Distillation	F.	F.	C.	C.	C.
IBP	150	145	79.7	110.2	*
50 Percent	210	170	80.1	110.8	
Dry Point	302	295	80.3	111.0	
Acid Wash Color					
Color of Acid Phase			0	0+	0+
Color of Hydrocarbon Phase			0	0	0+
Acidity, Mgs. NaOH/100 ml. Sample	No Free Acid				
Copper Strip Corrosion	Passed				

* Ethyl benzene, 14.5 weight percent; p-xylene, 19.0 weight percent; m-xylene 42.0 weight percent; o-xylene, 24.5 weight percent.

YIELDS	Percent by Volume of Extract	Percent by Volume of Udex Charge	Percent Recovery in Extract
Benzene	15.3	7.6	99+
Toluene	42.5	21.2	98
Xylenes and Ethyl Benzene	40.4	20.0	94
C_9 Plus Aromatics	1.8	0.9	75
Total Extract	100.0	49.7	
Raffinate	....	50.3	
UDEX Charge	....	100.0	

Commercial Installations: At the present time, there are 7 Udex units ranging from 500 to 7,112 barrels of charge per day in commercial operation. Another unit is now under construction.



Taking Stock

Cecil W. Smith,
Economics Editor

- Distillate stocks at all-time high
- Gasoline supplies ahead of 1954
- Current oil imports near peak

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,467	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	286	32,749	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	290	35,292	1,621	133,675	1,090	45,480	755	1,155
September	6,668	7,484	254,775	3,683	151,266	294	36,413	1,611	143,722	1,088	46,754	846	1,162
October	6,732	7,393	257,277	3,723	151,777	304	36,439	1,563	151,747	1,108	46,142	820	1,169
Week Ended:													
11-18-55	6,851	7,657	255,539	3,759	153,580	336	35,144	1,707	148,661	1,177	45,293	958	1,303
11-19-54	6,265	7,016	269,679	3,361	147,224	355	36,155	1,589	135,353	1,147	55,872	761	1,159

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

One of many advantages of 90/10 Cupro-Nickel

WELDABILITY

Welding head on filter shell

One of the relatively new copper base alloys is 90/10 Cupro-Nickel, which is coming into increased use as a result of experience with it. Revere offers it in sheet and plate, pipe and tube. It is highly resistant to corrosion and erosion, particularly in salt or brackish water. In addition it can be cold or hot worked, welded, soldered and polished. Because its nickel content is less than the older 70/30 alloy, it is priced lower.

The item shown here is a 90/10 Cupro-Nickel filter for aviation gasoline, designed and fabricated by the Warner Lewis Company, Division of Fram Corporation, Tulsa, Oklahoma, for the U. S. Navy. Heads and shell are 1⅛" thick. Revere was given the opportunity to collaborate with the Warner Lewis manufacturers on welding, which was successfully accomplished by the metallic arc process, using Inco 70/30 Cupro-Nickel electrodes. The vertical weld on the shell was X-rayed 100% and found satisfactory to pass Navy inspection. Because of the thickness of the metal, it was decided to form the heads hot at around 1690° F. The forming was done by the Hackney Iron & Steel Co., Enid, Okla., which also consulted with Revere.

Warner Lewis Company of Tulsa, with representatives in 30 cities, are specializing on all types of alloy design and fabrication and inquiries of this nature are invited.

If you wish information regarding the selection, welding, or working of copper and its alloys and aluminum alloys, see the nearest Revere Sales Office.

Completed aviation gasoline filter, made of 90/10 Cupro-Nickel

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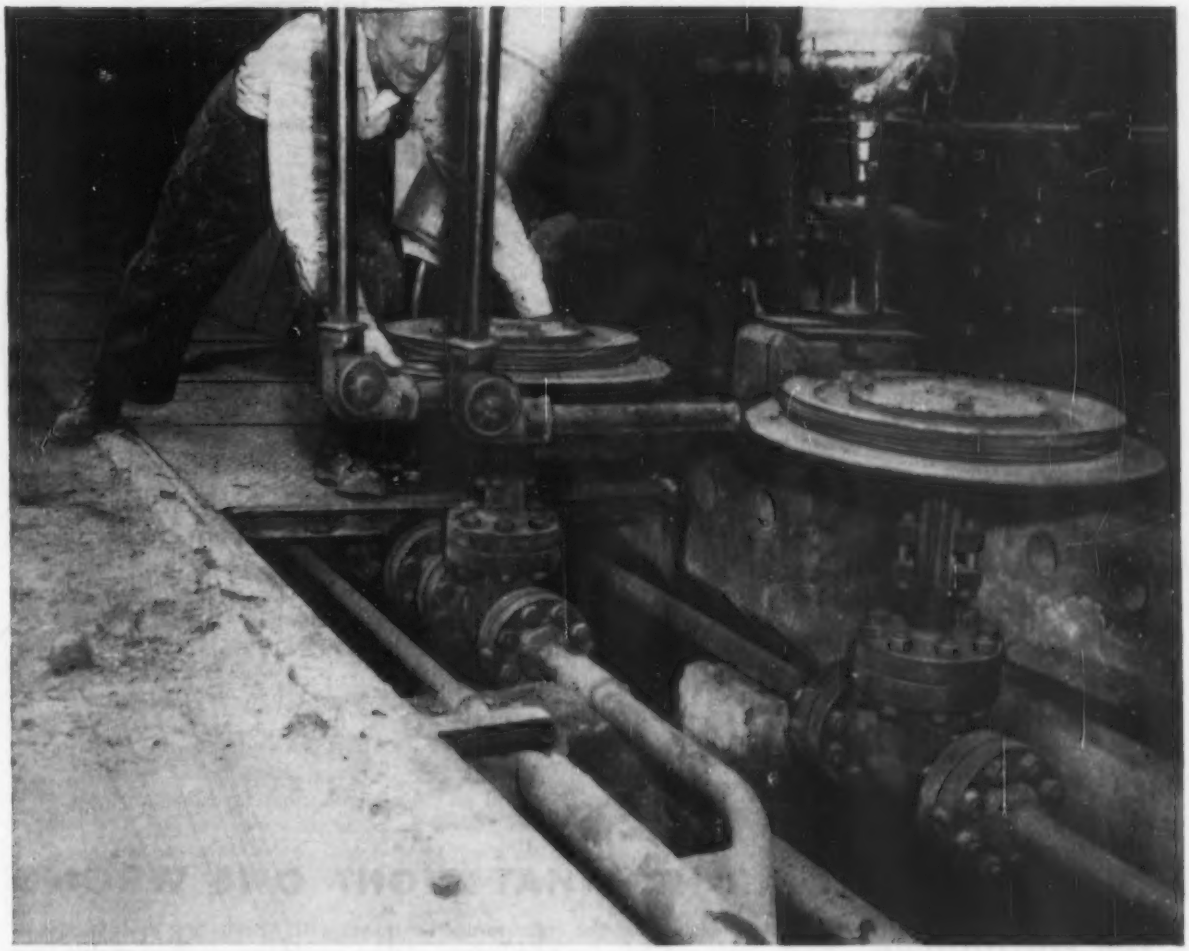


After 18 years on heater drop-out service . . . these valves ask for more

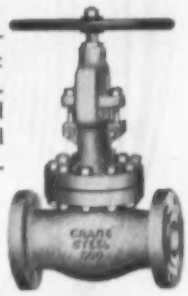
THE CASE HISTORY—18 years on one of the toughest refinery services at a cost of simple routine maintenance! That's the record of these 1500-pound cast steel globe valves—installed in 1937—at a DX-Sunray Oil Co. refinery.

What's more, these valves on intermediate heater control at 950° F., and on the light oil heater at 1025°, show no deterioration or loss of original efficiency. They look good for service indefinitely. There's not a sign of any leakage, and they open and close easily, with no sticking.

Crane No. 189X 1500-pound globes have a long record of low-cost refinery service like this.

Outwardly they look like many other valves of this type. Their important difference is inside—in Crane's greater skill and care in steel casting—in developing Exelloy seating for hot oil and vapor—in Crane operating design and Crane's thorough testing of valves.

You can get Crane quality in steel gate, globe, angle, and check valves in pressure classes up to 2500 pounds—in sizes up to 24 inches. Call your Crane Representative for valuable help in specifying and ordering.



Crane Co., General Offices: Chicago 5, Illinois. Branches and Wholesalers in all industrial areas.

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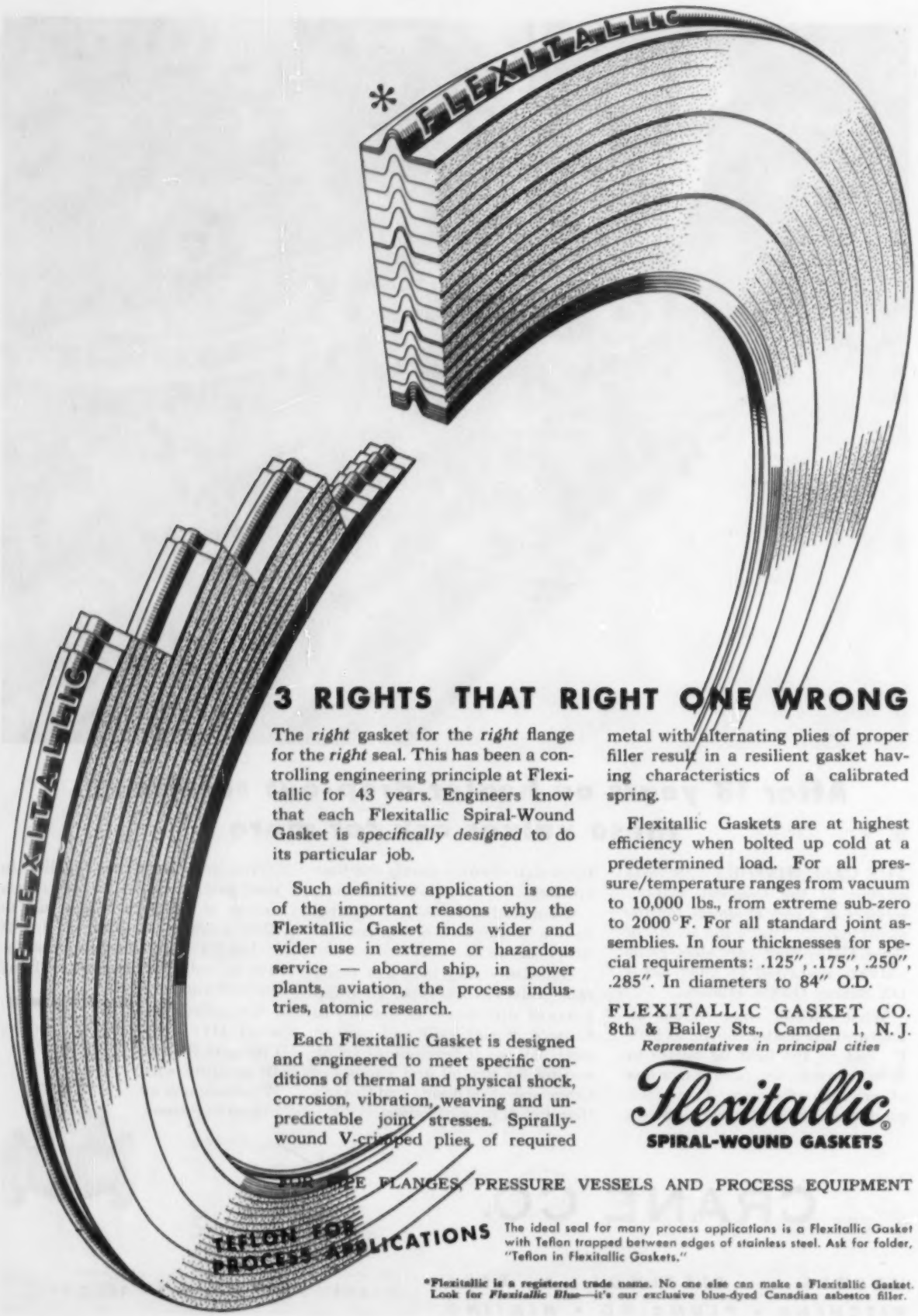
For more data on advertised products, use Readers' Service Cards, last page.



3 RIGHTS THAT RIGHT ONE WRONG

The *right* gasket for the *right* flange for the *right* seal. This has been a controlling engineering principle at Flexitallic for 43 years. Engineers know that each Flexitallic Spiral-Wound Gasket is *specifically designed* to do its particular job.

Such definitive application is one of the important reasons why the Flexitallic Gasket finds wider and wider use in extreme or hazardous service — aboard ship, in power plants, aviation, the process industries, atomic research.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O.D.

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FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

TEFLON FOR PROCESS APPLICATIONS The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .

Skid-Mounted Gasoline Plants To Be Leased

Skid-mounted gasoline plants now can be rented under a plan announced by a Bartlesville, Okla., firm. Under the plan, Elsey Corporation will begin leasing plants of capacities from 1 Mmcf. a day to 60 Mmcf. and larger.

Built to the lessee's specifications, complete with compressors, the plants will be available in multiples, to step up production. They are designed for flexibility, and expected to meet the changing conditions and requirements.

The plan will enable small producers, who have been unable to purchase plants, to take up natural gas and gasoline operations without a capital outlay. In the case of larger producers, capital can be freed for other ventures.

It was expected that the plan might permit some producers to realize four times their present income without investing in plant equipment.

Kwinana refinery rated at 60,000 barrels a day.

Australian Refining Capacity Increased to 160,000 Barrels

The British Petroleum Company's new 60,000-barrel-a-day refinery on Cockburn Sound at Kwinana, Australia, has been formally opened.

The new installation is the largest of four modern refineries constructed in Australia by international oil companies in the past few years. Together, they represent an investment of more than $254,224,000, and virtually assure the country of self-sufficiency in petroleum products.

In addition to Kwinana, which started operations early this year, the new refineries include:

- A 28,000-barrel-a-day refinery of Shell Refining (Australia) Pty., Ltd., opened near Melbourne more than a year ago.
- A 27,000-barrel-a-day expansion by Standard-Vacuum Refining Company (Australia) Pty., Ltd., completed at Melbourne early this year.
- And a 22,000-barrel-a-day refinery of Australian Oil Refining, Ltd., an associate of the Caltex organization, now under construction at Botany Bay, and expected to be in operation in a few months.

When this chain of refineries is fully on stream in 1956, Australia will have a capacity to process about 160,000 barrels a day, compared to about 20,000 barrels in 1951 and 40,000 barrels in 1954. The country's total oil consumption in 1954 amounted to some 115,000 barrels a day, and con-

Texaco Starts New Cuban Refinery; Shell Plant Already Under Construction

The Texas Company has started construction on its 20,000-barrel-a-day refinery at Santiago, Cuba. The refinery, a $14-million installation, will go on stream early in 1957.

Already under construction in Cuba is the Cia. Petrolera Shell de Cuba refinery, going up near Havana. The Shell plant, designed for a daily capacity of betwen 25,000 and 30,000 barrels, is due for completion late in 1956.

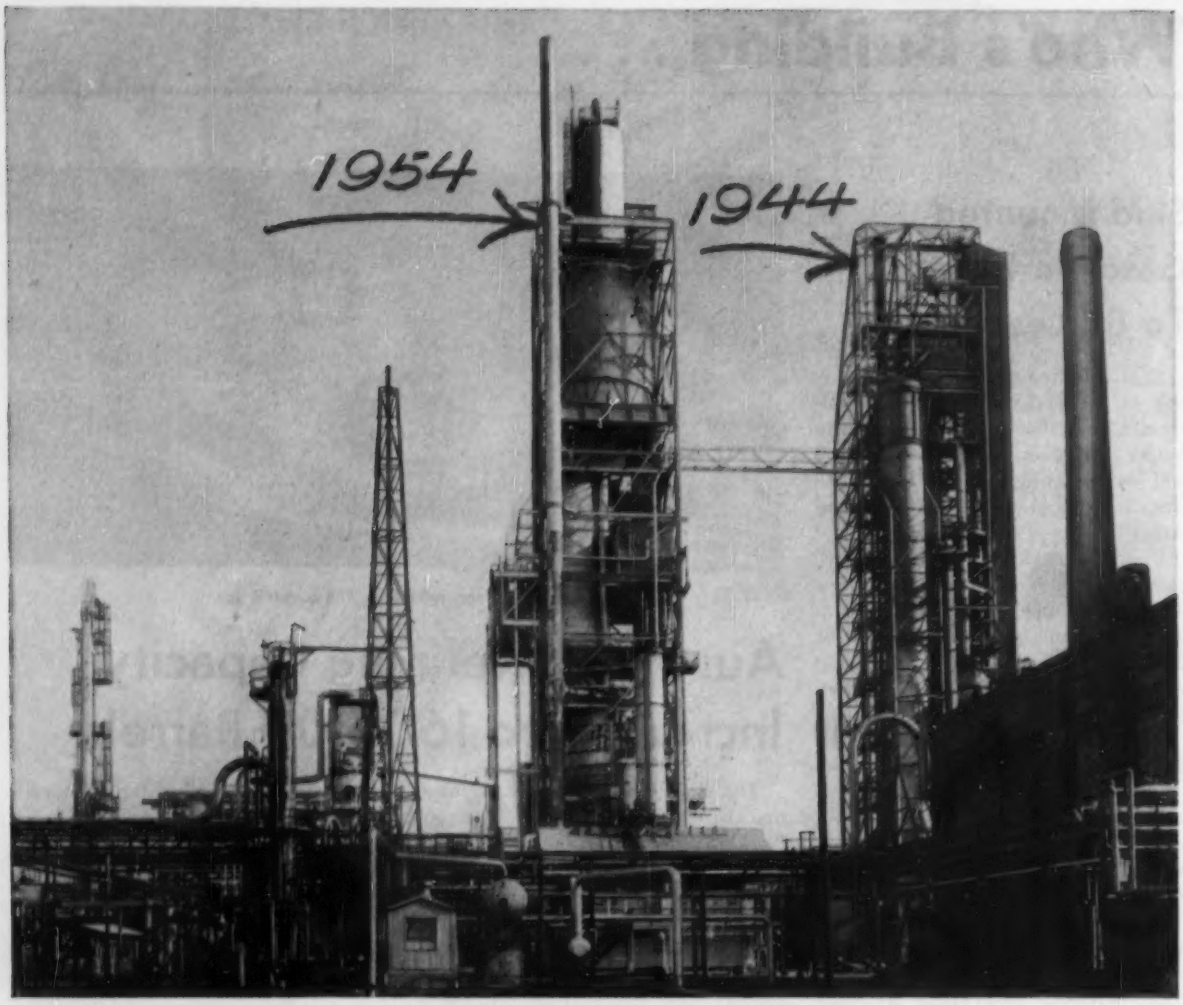
Cuba's refining capacity now is about 10,000 barrels a day, while consumption of petroleum products last year ran approximately 56,000 barrels a day.

The new Santiago refinery will be operated by The Texas Company (West Indies), Ltd., a wholly-owned subsidiary. Construction is being handled by the parent company's Construction department.

Equipment at the Texaco refinery will include a 20,000-barrel-a-day crude-distillation unit, a 3300-barrel-a-day catalytic reformer, a 4100-barrel-a-day hydrotreating unit and a gasoline sweetening unit.

About half the refinery's output will be fuel oil, a fourth kerosine and diesel oils, with the rest gasoline.

The Shell refinery, a $19-million project, is being built by Bechtel Corporation. Its process equipment will include crude distillation, a Platformer and ancillary units.



NEW T.C.C. UNIT JOINS 10 YEAR OLD SISTER AT EAST ST. LOUIS REFINERY

Two Thermofor Catalytic Cracking Units stand here side by side at Socony Mobil Oil Company's East St. Louis refinery, where for 10 years one stood alone. Both were engineered and constructed by The Lummus Company.

The first unit, with 10,000 B/D total charge and bucket lift for catalyst, went on stream in 1944 and has operated satisfactorily ever since.

The second unit, complete with feed preparation, fractionation, and gas recovery sections and using gas lift for catalyst circulation, went on stream in November 1954. Its total charge is 15,000 B/D.

We feel that the confidence which Socony showed in choosing Lummus for the repeat unit, and the installation of other East St. Louis facilities at the same time, was justified by our performance on the job.

Working closely with Socony engineers at the refinery and in their main office in New York, Lummus performed all work with a minimum of interruption to normal refinery operations – thus maintaining maximum possible refinery production.

The construction proceeded smoothly without interruption, and start-ups of the separate units were in line with a pre-established schedule, dovetailing them with periodic refinery maintenance shutdowns.

Perhaps this suggests some ways in which Lummus might serve you when you consider new or expanded facilities.

The Lummus Company, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Ind.

LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS
FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

sumption has been rising about 10 percent a year.

The new refinery will be operated by Australasian Petroleum Refining, Ltd., an Australian affiliate of British Petroleum.

Tide Water Associated Oil Company has started construction on the fourth unit of its 130,000-barrel-a-day Delaware City, Del., refinery. The unit, a vapor-recovery gas plant, will have a daily capacity of more than 90 Mmcf. It will handle all the light gases from the refinery's crude oil and gasoline processing units.

The British Petroleum Company, Ltd., plans to build a 2600-barrel-a-day alkylation plant at its Kent, England, refinery for the production of gasoline. The new unit, to cost about $18.2 million, is due to go into operation in 1958.

Lago Oil & Transportation Company is planning an expansion of its distillate-upgrading facilities at Aruba, N. W. I. The company, a Standard Oil Company (New Jersey) affiliate, has picked Badger Manufacturing Company to handle the project. An existing solvent-extraction unit will be expanded by 20,000 barrels a day. The project is expected to cost more than $3 million.

Esso Development Company, Ltd., is planning a large-scale expansion of its Esso European Laboratories at Abingdon, England. The project, due for completion towards the end of 1957, will include the installation of new engine-testing equipment, analytical, inspection and research laboratory facilities and new office space.

Badische Anilin und Soda Fabrik, with Deutsche Shell, A. G., has started operations at the first major petrochemical plant completed in Germany since World War II. Built at Wesseling, near Cologne, the new Rheinische Olefinwerke will turn out about 10,000 tons of polyethylene a year. As a raw material, the plant uses refinery gases from the nearby Shell refinery.

N. V. De Bataafsche Petroleum MIJ is to build a synthetic-glycerine plant adjoining its Pernis, Netherlands, refinery. In the U. S. Shell has been manufacturing glycerine from propylene for several years, and is planning to build another plant at Norco, La. Its $7-million Pernis plant, however, will be the first in Europe to make the chemical.

Caltex Petroleum MIJ (Netherland), N. V., is expanding its refinery at Pernis. The capacity of the refinery is now 31,000 barrels a day. The company has asked the municipality to reserve a 200-acre plot for the expansions.

Cooperative Refinery Association has awarded the contract for construction of two new process units at its Coffeyville, Kansas, refinery. Southwestern Engineering Company was picked to build a 5000-barrel-a-day Platformer, licensed by Universal Oil Products Company, and a 3000-barrel-a-day Unifier, licensed by UOP and Union Oil Company of California.

In addition to engineering and constructing the units, Sweco will fabricate several vessels, heat exchangers and other equipment needed for the installation. The two-unit project is scheduled for completion in February 1956.

Michigan Chemical Corporation, with Murphy Corporation, will build a jointly-owned plant for producing bromine near El Dorado, Ark. The plant, to be operative by fall 1956, will obtain its supply of bromine gas from the oil districts of southern Arkansas. Michigan Chemical will handle plant operations, and Murphy will supply raw materials.

Famaris Oil & Refining Company has gone on stream with a new combination Platforming-Unifining unit at its Hobbs, N. M., refinery. The unit, designed for a daily capacity of 650 barrels, was built by refinery personnel.

Montana Sulphur & Chemical Company will start construction on a 42-ton-a-day sulphur plant near Billings, Mont. The company, recently formed, will use hydrogen-sulfide gases from the neighboring Carter Oil Company and Continental Oil Company refineries.

Continental Oil Company is nearing completion on its $700,000 natural-gasoline plant near Sussex, Wyo. The plant will be capable of processing 15 Mmcf. of gas a day. Scheduled to operate in conjunction with Conoco's $1,750,000 gasoline-recovery and gas-repressuring plant at Sussex, the new facility will produce gasoline, butane and propane. The company also operates a natural-gasoline plant at Lance Creek in Wyoming's Niobrara County and is part owner in another plant at Elk Basin, near Cody.

Paragon Oil Company, Inc., plans to build a 30,000-barrel-a-day refinery at Tiverton, R. I. J. F. Pritchard and Company is doing initial-design studies for the refinery. Process equipment will include desulfurization facilities.

United Refining Company, repairing the burned-out Seneca branch of its Warren, Pa., refinery, expects to have the facilities back in operation by early spring 1956.

Southwest Gas Producing Company has placed a new reforming unit on stream at its Dubach, La., natural-gasoline plant. The unit, an 1800-barrel-a-day Platformer, is part of a $750,000 plant expansion program, and enlarges the gas and liquids handling capacity to the equivalent of 190 Mmcf. a day. The installation was made by Fish Engineering Corporation.

Who's Building . . .

North Star Oil, Ltd., has opened its new St. Boniface refinery. The installation, built for a daily capacity of 12,000 barrels, was expected to reach its full capacity from the outset. The plant was built to replace the company's older St. Boniface refinery, being moved to Grande Prairie. It cost some $10 million. Engineering and construction was handled by Canadian Kellogg Company, which also is in charge of relocating the older refinery.

Royalite Oil Company has opened its new 5000-barrel-a-day Kamloops, B. C., refinery. The plant has a 1425-barrel-a-day fluid catalytic cracker and a catalytic polymerization unit rated for a daily capacity of 100 barrels.

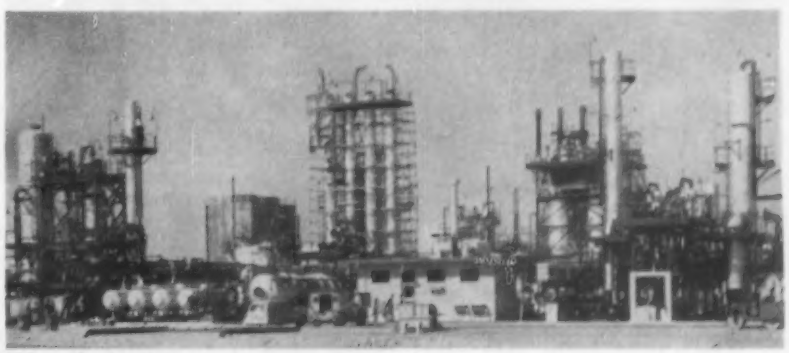
Sun Oil Company has scheduled a $1.7-million expenditure on new facilities at its Toledo refinery. A new alkylation unit, to cost $1.2 million, will be in operation by May 1956. The remaining $500,000 will be used to build a laboratory.

The Atlantic Refining Company is nearing completion on a one-story centralized stores warehouse at its Point Breezy, Pa., refinery. The warehouse, a 125,000-square-foot structure started in March 1955, will be used to store and disburse maintenance and construction material. About 90 percent of the material will be used in the refinery, with the remainder going for servicing outside terminals.

Pennsylvania Salt Manufacturing Company will start construction on a new organic fluorine chemicals plant at its Calvert City, Ky., works. The new unit, with operations slated for 1956, will be a major component of Pennsalt's intergrated chlorine-fluorine production facilities on the Tennessee River.

Southland Oil Company will start construction on a $25-million refinery at Tampa, Fla. The refinery, to be built for a capacity of between 25,000 and 30,000 barrels a day, will produce gasoline, jet fuel, kerosine, asphalt and other products.

Phillips Chemical Company has a new sales service laboratory under construction adjacent to the Chemical Research laboratories being built by its parent company, Phillips Petroleum Company at the



California Plant Nears Completion—

Standard Oil Company of California will put its new isophthalic-acid plant on stream at Richmond before the end of the year. The plant, the first of its kind in the world, will turn out 50,000 pounds of the chemical a year. It will have cost more than $10 million to build.

Phillips Research Center in Bartlesville, Okla. The structure will provide space for a variety of facilities required for developments in the thermoplastic field. It will have 15,000 square feet of floor space.

Societe du Caoutchouc Butyl, a consortium of 10 rubber, chemical and petrochemical concerns, will build a 20,000-ton butyl rubber plant in France's Basse-Seine region. The SOCABU installation will be completed by mid-1958.

National Silicates, Ltd., will build a sodium-silicates plant at Valleyfield, Que. The new installation will go up adjacent to a synthetic-cracking-catalyst plant being built by Davison Chemical Company. Construction of the silicates plant will start in the spring of 1956. Most of its product will be used at the Davison plant.

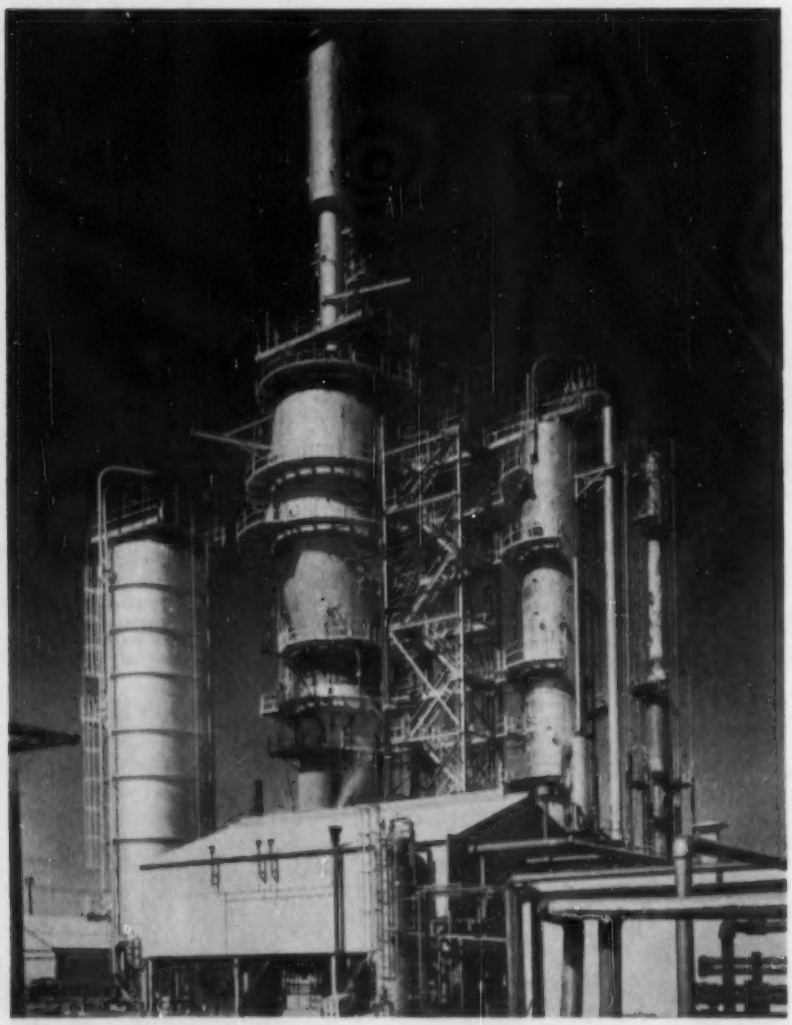
Du Pont Company will build a new sulfuric-acid plant near Cincinnati. Construction will start immediately, with the plant scheduled to begin operations late in 1956.

To be known as the Fort Hill Works, the new unit will be built by Du Pont's Engineering department and will be operated by its Grasselli Chemicals department. The plant will replace the plant now operated by Grasselli at Lockland, Ohio, near Cincinnati.

The Lockland plant will continue operations until the new plant is in commercial production.

Union Carbide and Carbon Company will build a polyethylene plant near Grangemouth, Scotland, where British Petroleum Chemicals, Ltd., is installing additional ethylene facilities. The Union plant, to be on stream by mid-1957, will make 26 million pounds a year.

The new construction makes Union a chemical producer in three countries, the U. S., Canada and now the United Kingdom.



Oklahoma Unit On Stream—

Now on stream at Champlin Refining Company's refinery in Enid, Okla., is a new Orthoflow catalytic cracking and gas recovery unit. Designed to charge 9000 barrels a day of wide-cut gas oil for producing high-octane gasoline and burning oils, the unit was built by The M. W. Kellogg Company. In addition to the cat cracker, a Platforming unit and a second polymerization unit have been constructed and also are on stream.

Who's Building...

Salt Lake Refining Company will start construction, to increase the flow of crude to its Salt Lake City stills by 15 percent. The project, to be started in December 1955, will add between 4800 and 5000 barrels to the refinery's present rate capacity of 32,000 barrels a day. The company is a subsidiary of Standard Oil Company of California.

Rock Island Refining Corporation has gone on stream at Indianapolis, Ind., with the first Unifiner to be controlled electronically. The new 300-barrel-a-day unit serves as a feed-preparation section for producing additional charge to a 2400-barrel-a-day catalytic reformer which went into operation about a year ago.

Process engineering and design was handled by Universal Oil Products Company which also engineered the electronic instrumentation. The installation was made by refinery personnel.

The product of the Unifiner goes to the reformer feed-preparation tower which produces light-treated gasoline as an overhead stream for gasoline blending. The naphtha bottoms are used as charging stock to the reformer. Charge stock to the Unifiner is vis-breaker gasoline.

Hydrogen from the reformer is used in the Unifiner without compressors. The heat pickup required is obtained from heat exchange from the Unifiner's reactor products and from the reformer's reactor effluent.

U. S. Industrial Chemicals Company, Division of National Distillers Products Corporation has completed a new reforming unit to produce hydrogen from natural gas at its Tuscola, Ill., ammonia plant. The raw material for the company's ammonia operation has been hydrogen from the neighboring ethylene-production facilities of National Petro-Chemicals Corporation, a subsidiary of National Distillers. The new unit, engineered and built by The Girdler Company, will supplement the available hydrogen and make possible the operation of the company's 150-ton-a-day ammonia plant at full capacity.

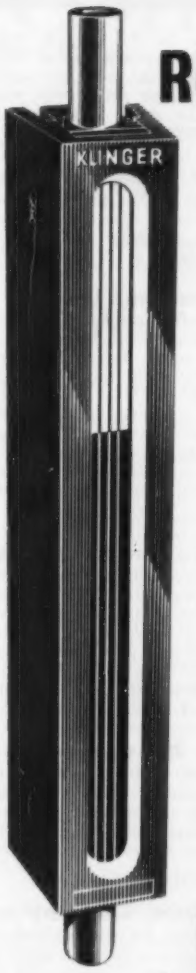
Idemitsu Kosan Company is negotiating a $10-million loan from the Bank of America for reconstruction of the former naval refinery at Tokuyama, in western Japan. Another Japanese firm, Showa Oil Company, expects to rebuild the former naval refinery at Yokkaichi. The two refineries, when restored, will process some 20,000 barrels a day of crude.

Shell Oil Company has accepted its new 50,000-barrel-a-day Anacortes, Wash., refinery from the contractor. The plant, built at a cost of some $75 million, was erected by Bechtel Corporation. The catalytic cracker was the only process equipment not yet in operation. The refinery has been in partial operation several weeks.

Cooperative Refinery Association has gone on stream with a new catalytic reforming unit at its Scottsbluff, Neb., refinery. The 650-barrel-a-day unit was design, engineered and licensed by Universal Oil Products Company. The association will put another reformer on stream later.

Mediterranean Refining Company is scheduling the start-up of a new catalytic reforming unit at its Sidon, Lebanon, refinery. The new unit, a Platformer, will

Reliability and Readability



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Single row of tightening bolts.
Body free from distortion
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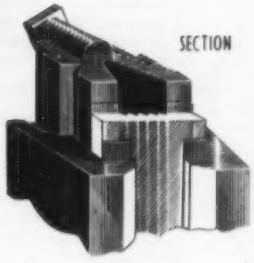
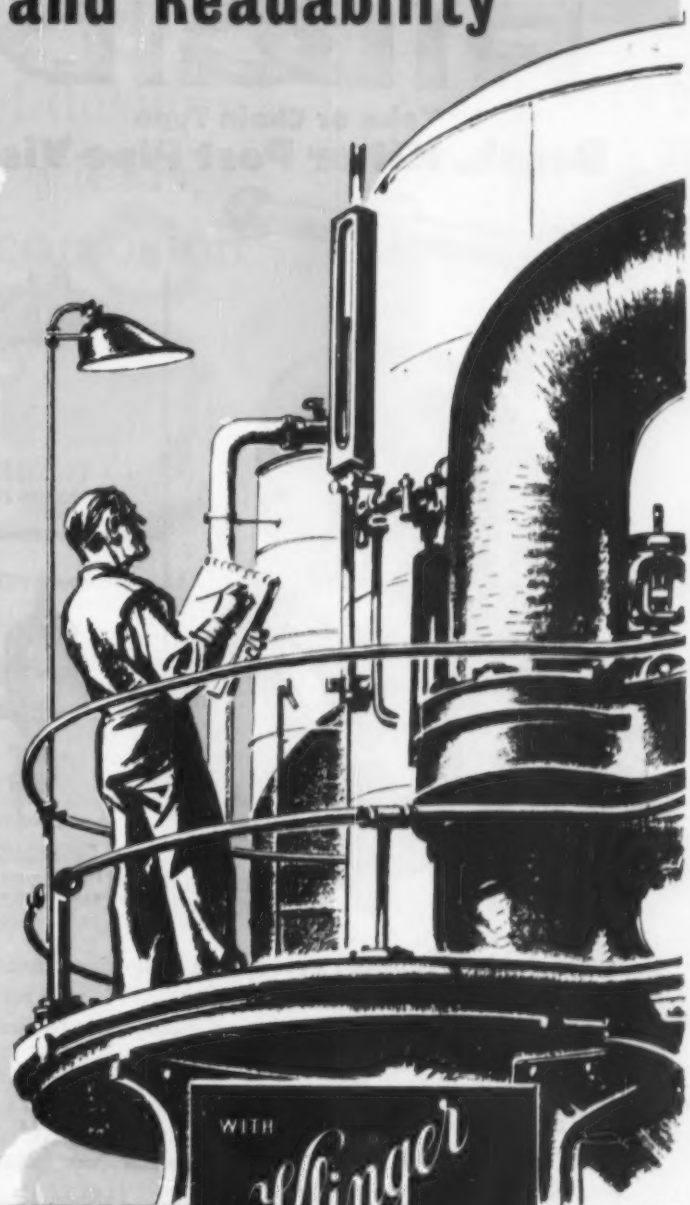
Gage body turnable, free to expand, and easily removed.



Write for the Klinger Master Catalog which describes the complete range of Klinger products.



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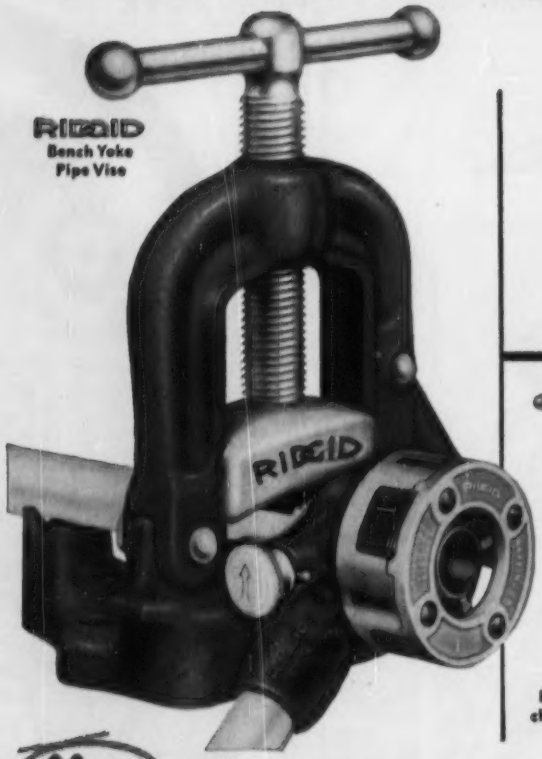
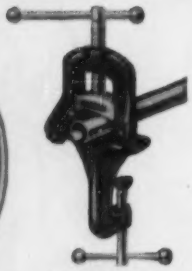
Bench, Kit or Post Pipe Vise



RIDGID Bench Yoke Pipe Vise

RIDGID Bench Chain Pipe Vise



RIDGID Kit Pipe Vise, portable, clamps on bench or plank

More efficiency... special design jaws that grip firmly . . . close and open fast . . . pipe rests for more accurate threading, easy cutting . . . handy pipe benders.

More service... famous RIDGID heat-treated jaws for extra long wear . . . special malleable frames that won't warp or break . . . every vise factory tested to assure you super-performance and durability.

Get most for your money— buy RIDGID Vises, including stand and tristand, at your Supply House!

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Who's Building...

permit an increase in the plant's crude thruput from 6250 barrels a day to 9000 barrels. A duplicate of the reformer which went on stream at Sidon earlier this year, the new unit is the third Platformer in operation in the Middle East.

Dunlop Rubber Company is building a new synthetic-rubber plant in England. The plant, intended for experimental purposes, will turn out some 2000 tons of synthetic rubber a year.

Shamrock Petroleum, Ltd., has a refinery with a daily capacity of some 3000 barrels a day proposed for construction at Whitehorse in the Yukon Territory. Whitehorse is about 1000 miles north of Edmonton.

A contract for engineering and construction is being negotiated by The Fluor Corporation of Canada. The project is expected to be started early next spring, with the refinery due for completion late in 1956.

Southern Nitrogen Company, building a 250-ton-a-day ammonia plant at Savannah, Ga., has awarded The Girdler Company the contract to handle construction. The plant, a $14-million project, will be based on natural gas. It is scheduled to go into operation late in 1956. Ammonia will be converted into nitrogen solutions for fertilizer and prilled ammonium nitrate.

Esso Standard Oil Company will build a new ethylene-recovery plant at its Bayonne, N. J., refinery. The equipment will be the first on the Atlantic seaboard to supply concentrated ethylene. Ethylene processing has been centered in the Gulf Coast area.

Phillips Petroleum Company has awarded the contract for construction of a 75-Mmcf-a-day natural gasoline plant in Andrews County, Texas. Construction of the new plant, to be started early in 1956, will be handled by Gasoline Plant Construction Company, a Houston firm.

D-X Sunray Oil Company has completed and put on stream a 7000-barrel-a-day delayed-coking unit at its West Tulsa refinery. The new unit, taking crude residual from the refinery's crude stills and converting it to lighter and more valuable products, processed 4000 barrels of gas oil a day and 240 tons of coke.

Gas oil from the coker is fed to the catalytic-cracking plant to be used in the manufacture of gasoline and burner distillate. The coke is sold for use in metallurgical processes. The delayed coker, which replaces a viscosity breaking plant long used at the refinery, takes D-X Sunray out of the residual fuel field.

The delayed coking plant, a $2.5 million installation, was engineered and built by The M. W. Kellog Company.

Ingram Oil & Refining Company has awarded the contract for construction of new facilities at its Meraux, La., refinery. The work will be done by Southwestern Engineering Company.

The new equipment will include a 3000-barrel-a-day catalytic-reformer, licensed by Universal Oil Products Company, as well as prefractionation and light straight-run

Corrosioneering News

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New glassed steel designs offer you better yields, lower costs, less corrosion

No contamination, no leakage with new seal for reactors

No metallic contamination of your product. No stray, unwanted catalysts. No escaping vapors.

These are the advantages of a new nonmetallic rotary Crane-type seal now available on Pfaudler glassed or stainless steel reactors up to 100 gallons. (A similar design is also available for larger units.)

Only Pfaudler glass, Teflon, ceramic and carbon come into contact with your product. Design of the seal is simple, easily maintained.

New development boosts corrosion resistance of columns

Better results from fractionation and other processes requiring a column are now possible with the added corrosion resistance of a new Pfaudler development.

It's a glassed steel distributor plate, available for all size columns. Using Pfaudler acid-alkali-resistant glass, this plate provides complete flexibility of use over a range up to pH 12 at 212° F.

The corrosion resistance of this glass protects product purity, simplifies cleaning, and protects your equipment investment.

Dryer-blender tumbles out 4 days' work in 7 hours

In actual use, a Pfaudler glassed steel conical dryer-blender is producing as much dried product in 7 hours as formerly required at least 4 working days, using a different type of dryer.

Double-cone shape, tumbling action and efficient heating design are responsible for this great speed. In addition, a broad range of corrosive applications is possible, because the unit is fabricated of Pfaudler's special acid-alkali-resistant glassed steel.

To pre-test your product in the Pfaudler dryer-blender, a small 2′-

diameter test model is available. Write or phone your Pfaudler representative for full details.

New Pfaudler hydraulic drive and seal

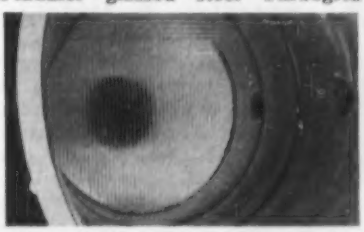
The new Pfaudler hydraulic drive and seal offers many advantages: It can be made in both stainless steel and glassed steel construction for a large range of reactor sizes and for greater horsepower requirements with either hydraulic or air motors.

Any noncorrosive fluid can be used as a seal – even one of the ingredients of your own product – providing you 100% protection against contamination.

This seal is operated under pressure, requires a minimum of maintenance, and is designed to give years of trouble-free service. Your Pfaudler representative can provide full details at your request.

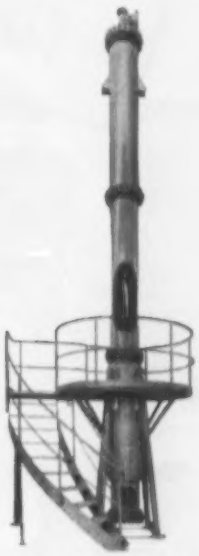
New Turbogrid tray gives higher yield at lower cost

You're looking down the throat of a Pfaudler glassed steel Turbogrid



column, at a new tray design that provides enormously high capacities, yet lowers the cost of the column itself.

The tray is constructed of high-strength PYREX brand glass tubes,



Cutaway column, providing an unusual view of the "business side" of Pfaudler glassed steel construction, was a feature attraction at Chemical Industries Exposition, Philadelphia.

with all their inherent advantages of corrosion resistance, physical toughness, and thermal shock resistance.

Because of the high capacity resulting from this design, the column itself can be of smaller diameter than previously required – an important means of cutting its cost.

Now—variable agitator speeds ranging from 60 to 340 RPM

Six different agitator speeds: 60, 90, 120, 175, 250, and 340 RPM are now available on Pfaudler reactors up to 100 gallons.

These are made possible by interchangeable constant-speed sheaves of the new PW drive. As an alternative, variable pitch sheaves may be supplied, giving quick adjustment for *all* speeds ranging from 60 to 300 RPM.

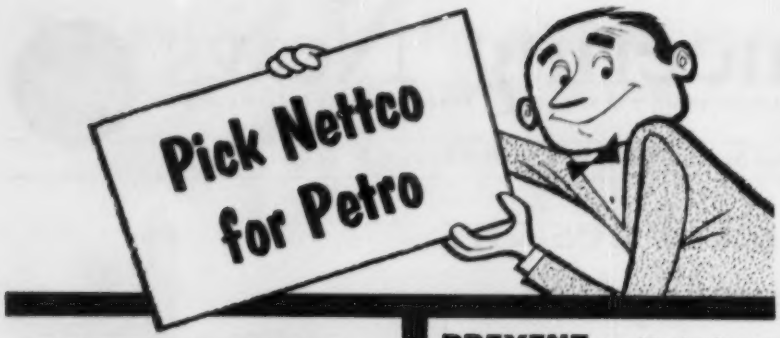
The new PW drive rides high above the top head of the reactor, out of the way so you can have easy access to other nozzles.

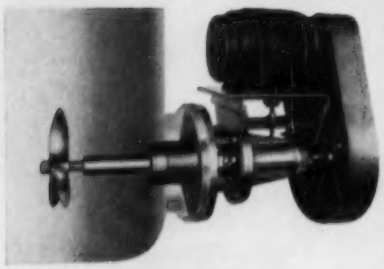
Write for Bulletin 923.

Which material of construction for you?

Glassed steel, stainless, titanium, Inconel, Hastelloy, copper and copper alloys, and many other corrosion-resistant materials are commonly used by Pfaudler to solve processing problems. Write today for free, unbiased analysis of *your* problem.

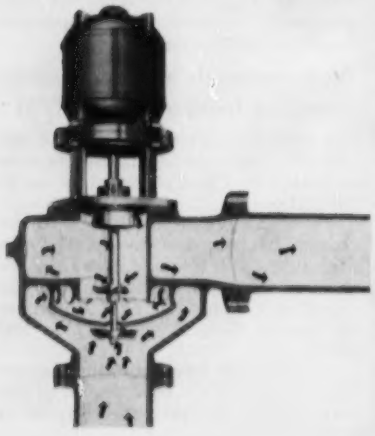
For more data on advertised products, use Readers' Service Cards, last page.





PREVENT stratification in storage tanks . . . with Nettco Side-Entering Agitators — for tanks up to 5 million gallons capacity. Available in most alloys, with four stuffing box modifications including special Nettco design which permits repacking gland without draining tank using either mechanical shaft seal or conventional packing. Speed reducer models from ⅓ to 25 HP — direct driven, high speed units to 30 HP. Bulletin No. 532.

CUT processing time — with Nettco Tank Top Agitators. Ruggedly built agitator drives in 27 sizes and models for the most exacting services. Features include oversized Timken bearings widely spaced on large vertical shaft in enclosed housing with splash lubrication and oil-trap design to prevent leakage. Models from ⅓ to 50 HP — ratios from 3.5:1 to 2,000:1. Units include motors, shafts, stirrers, as required by the process conditions. Bulletin No. 551.



KEEP product flows "on stream" — with Nettco's Flomix — the pipeline mixer for 1" to 8" lines. This patented mixer speeds up processes by mixing fluids on stream. One refinery reports on Flomix on a caustic wash process: (1) 14% greater wash efficiency, (2) increased product uniformity, (3) improved inhibitor susceptibility, (4) elimination of two orifice towers, (5) simpler piping layout, and (6) greatly reduced maintenance time. Available in ⅓ to 3 HP motors, for line pressures to 300 psi — temperatures to 500°F. Bulletin No. 531.

Nettco engineering can help you at every stage in the development of agitation systems: preliminary design, preparation of specifications, manufacture of equipment to the most rigid specifications, and pretesting of the finished units. Check with Nettco today. New England Tank & Tower Co., 81 Tileston St., Everett 49, Mass.

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ENGINEERED AGITATION

Who's Building . . .

gasoline stabilization facilities. Estimated cost is about $1 million.

The reformer, being added to produce high-octane premium gasoline from low-grade straight-run and distillate stocks, is designed to permit addition of Rexformer extraction facilities. The new facilities are expected to be completed by April 1956.

Texas Eastman Company will expand its Longview, Texas, facilities for producing aldehydes. Capacity of both the n-butyraldehyde and isobutyraldehyde facilities will be increased. The project is scheduled for completion in the fall of 1956.

Cosden Petroleum Corporation, taking up the production of petrochemicals, has awarded the contract for construction of its proposed $3-million styrene plant at Big Spring, Texas, to Badger Manufacturing Company. The new plant, part of the expansion program already underway at Big Spring, will be in operation late in 1956.

Completion of a 3900-barrel-a-day Rexformer will release the Cosden refinery's existing platformer, for a conversion equipping it to prepare aromatic feedstock for the integrated Udex unit. With this unit, Cosden will have benzene, which, combined with ethylene, will provide a feed stock for making styrene.

The British Petroleum Company, Ltd., will build an $18-million processing plant at its Kent refinery, to produce 2600 barrels a day of aviation gasoline. The new plant will be in operation by 1958.

Canadian Industries (1954), Ltd., with a synthetic-ammonia plant to go up at Millhaven, Ont., has selected The Girdler Corporation of Canada, Ltd., to handle construction. The engineering phase of the project has been underway since May.

The plant, to produce 200 tons a day, will use the Texaco partial oxidation process, with residual fuel oil as raw material for synthetic-gas production. After purification of the synthesis gas, nitrogen will be added and the mixture compressed to 300 atmospheres, for the production of anhydrous liquid ammonia.

The plant is expected to be complete in mid 1956. It will cost some $9 million.

Imperial Oil, Ltd., will start producing jet fuel at its new Dartmouth, N. S., refinery, when the $30-million plant is completed in April 1956. Shortly after it will begin turning out propane. The refinery is expected to run more than 41,000 barrels of products a day, compared to the present 22,000 barrels.

Koppers Company, Inc., and **Brea Chemicals, Inc.,** are planning a 50-million-pound-a-year polyethylene plant. The new facility, to be located on the West Coast, will use the Zieglar-type process. A joint engineering team is studying location and operational details. The new plant is scheduled to be completed sometime in 1957.

American Oil Company has given The Ralph M. Parsons Company the contract for building three major operating units at its $25-million refinery at Yorktown, Va. Parsons will build the plant's 7600-barrel-a-day Ultraforming unit, a

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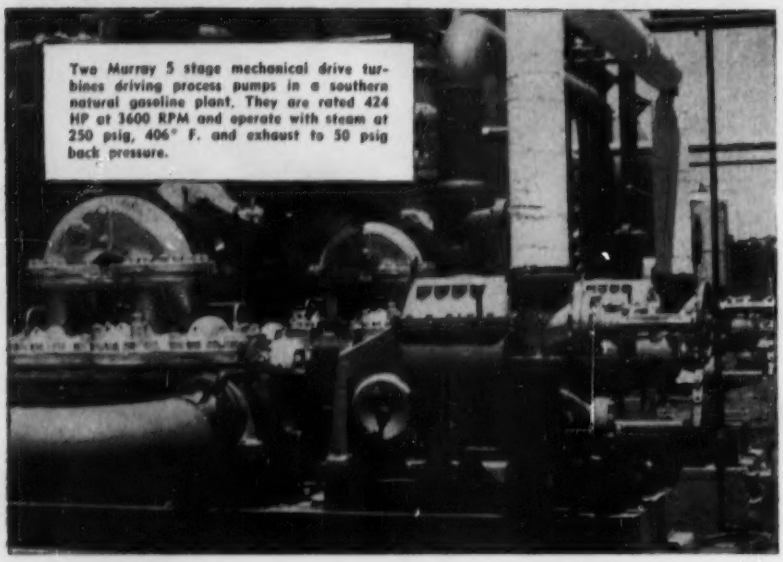

Two Murray 5 stage mechanical drive turbines driving process pumps in a southern natural gasoline plant. They are rated 424 HP at 3600 RPM and operate with steam at 250 psig, 406° F. and exhaust to 50 psig back pressure.

● MURRAY TURBINES for mechanical drive can be furnished for various combinations of the following conditions:

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Who's Building . . .

naphtha-desulfurization unit of the same capacity, and a 15,000-barrel-a-day desulfurization unit.

The Lummus Company and The M. W. Kellogg Company also hold contracts for construction and engineering on Virginia's first petroleum refinery. The plant, to be completed in late 1956, will have a daily capacity of 35,000 barrels.

Imperial Oil, Ltd., will start construction on a 10-Mmcf.-a-day natural gasoline plant near Redwater, Alta. A contract to build the $3-million plant went to Brown & Root, Ltd. The project, to be started next spring, will be completed by late 1956.

Stauffer Chemical Company will build another petrochemical plant at Louisville, Ky.—this one to produce carbon tetrachloride, chloroform, methylene chloride and anhydrous hydrogen chloride. Construction of the new plant, to use natural gas and chloride, will begin early in 1956, with completion scheduled for 1957.

The Texas Company, building a 4800-barrel-a-day catalytic reformer at its Casper, Wyo., refinery, has scheduled the new unit to go on stream early in 1956. This will be Texaco's tenth such unit built under a $72-million expansion program. The nine other reformers, already in operation, have a combined daily capacity of 101,000 barrels.

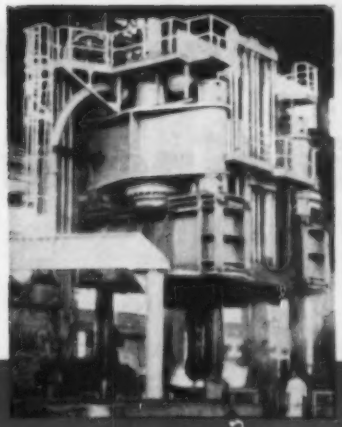
The Standard Oil Company (Ohio) has awarded the contract for construction of its Lima, Ohio, dry-ice plant to J. E. Pritchard & Company. The company also has increased the plant's design capacity to 100 tons a day from the originally projected 75 tons. Cost of the project, expected to be completed in April 1956, will range between $800,000 and $900,000.

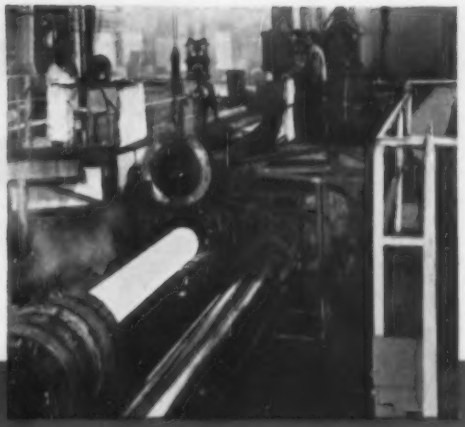
Canadian Gulf Oil Company will build a 225-ton-a-day sulphur plant near Lethbridge, Alta. It will be the largest plant of its kind in Canada. The Gulf Oil Corporation subsidiary has scheduled the new installation for completion in September 1956. In addition to sulphur, it will turn out some 1900 barrels of condensate a day.

Sinclair Oil & Gas Company has gone on stream with a new 20-Mmcf-a-day natural gasoline plant near Silsbee, Texas. The plant, owned jointly with several other operators, was erected by Disen Company.

St. Paul Ammonia Products, Inc., will build a $13.5-million plant, to produce anhydrous ammonia and other nitrogen products near St. Paul. The plant is due for completion by the end of 1956.

American Gilsonite Company has awarded two contracts involving more than $5 million worth of construction. These are the first contracts for the new Gilsonite coke and gasoline plant to be built in the Grand Junction, Colo., area. Foster Wheeler Corporation was picked to build the plant's delayed coking unit, and Kaiser Engineers received a contract for the calcining plant, utilities and auxiliary facilities.





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ASTM A 106 Grade A	Carbon Moly	P 1	Croloy 18-8	TP 304
ASTM A 106 Grade B	Carbon Moly High Silicon	P 15	Croloy 18-8 Ti	TP 321
ASTM A 106 Grade C	Croloy ½	P 2	Croloy 18-8 Cb-Ta	TP 347 (Cb-Ta)
	Croloy 1	P 12	Croloy 18-8 Cb	TP 347 (Cb)
	Croloy 1¼	P 11	Croloy 16-13-3	TP 316
	Croloy 1¾	P 3		
	Croloy 2	P 3b		
	Croloy 2¼	P 22		
	Croloy 3M	P 21		
	Croloy 5	P 5		
	Croloy 5 Si	P 5b		
	Croloy 7	P 7		
	Croloy 9-M	P 9		
Analyses such as SAE or AISI carbon steel will be considered if quantities are sufficient.	ASTM Spec. A 335 has superseded and replaced ASTM Specs. A 158, A 206, A 280 and A 315. This list includes all grades of A 335 except grade P 5c, which we do not make. B&W Croloys, 2½, 3, 5M, 7M, and 9, are not included in A 335. We will supply these additional alloys in accordance with A 335, except for chemistry, upon request.		These grades will also be made to ASTM specification A 376 excluding "special inspection" requirements. Other grades of Stainless Steel listed under A 312 are TP 309, TP 310, TP 317. These grades are presently not offered as standard, but will be considered on request.	

For the complete B&W Hollow Forgings story, send for new Bulletin S-16B. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

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S-461

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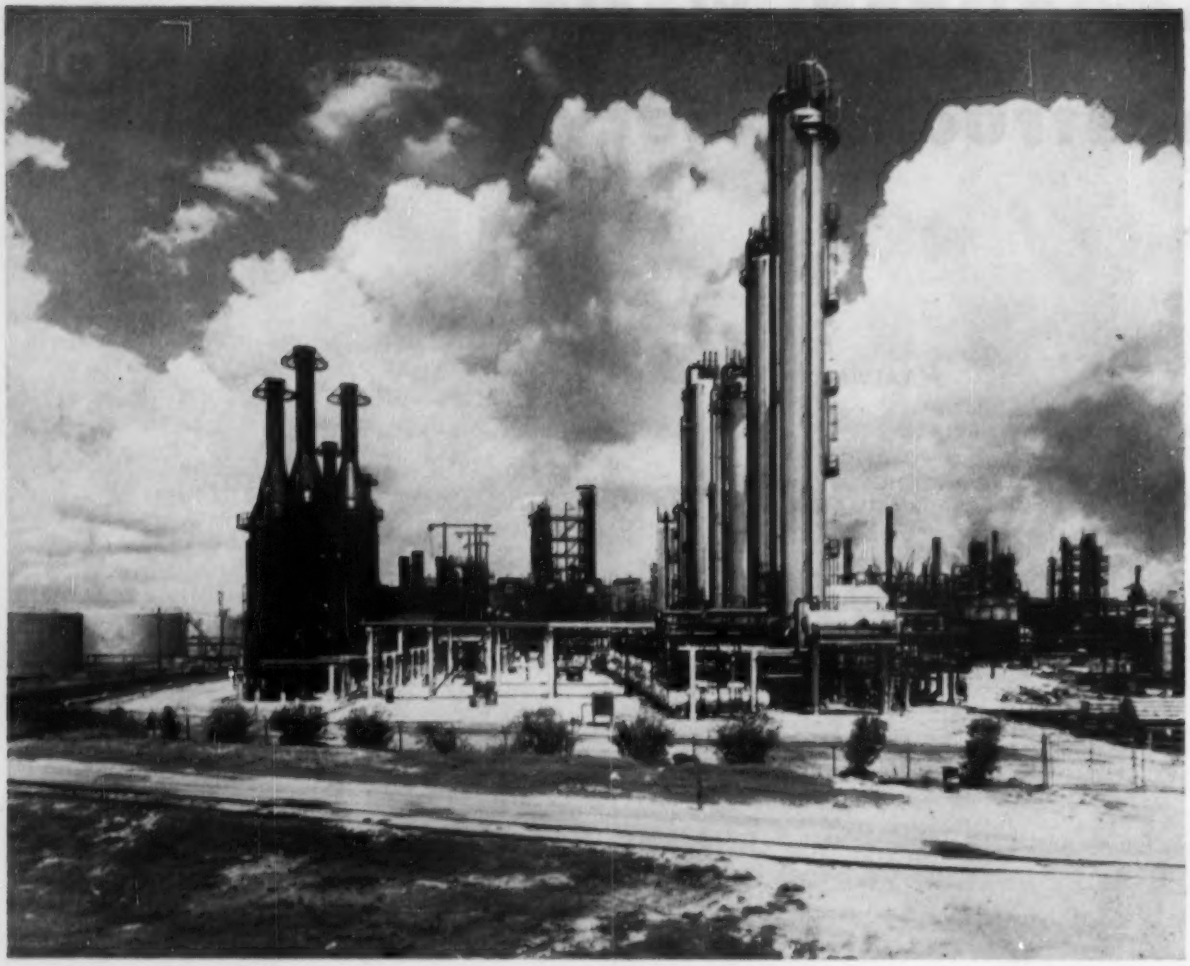

Completion of Gulf's new 29,000-barrel-a-day catalytic reformer at Port Arthur marked the end of a project to add 65,000 barrels a day of new reforming capacity at the four largest Gulf refineries.

Gulf's Capacity Continues Climb

. . . In the decade since World War II, Gulf has increased its daily thruput from 323,000 barrels to 519,000, and is still expanding its facilities.

FOLLOWING WHAT has become a general trend in the petroleum-refining industry of the postwar decade, Gulf Oil Corporation has reduced the number of its refineries, while at the same time increasing its total refining capacity.

When World War II ended, Gulf was operating eight wholly-owned U. S. refineries, with a rated capacity of 323,000 barrels a day. Today, the company is running only five plants, but with these it has a daily capacity of 519,000 barrels.

Because their locations did not justify the expansion and moderniza-

This is the third in a series of articles dealing with postwar expansion and modernization in the petroleum-refining industry. In January, we will take up Socony Mobil.

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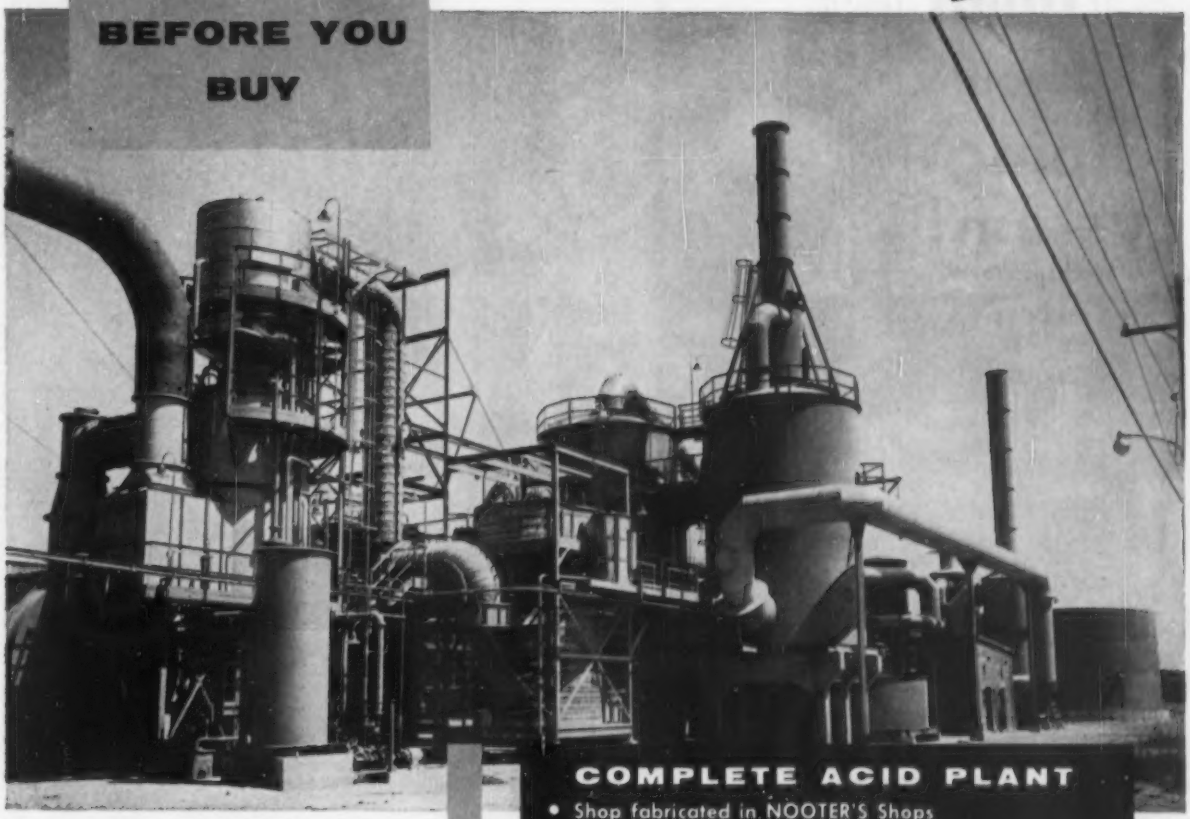

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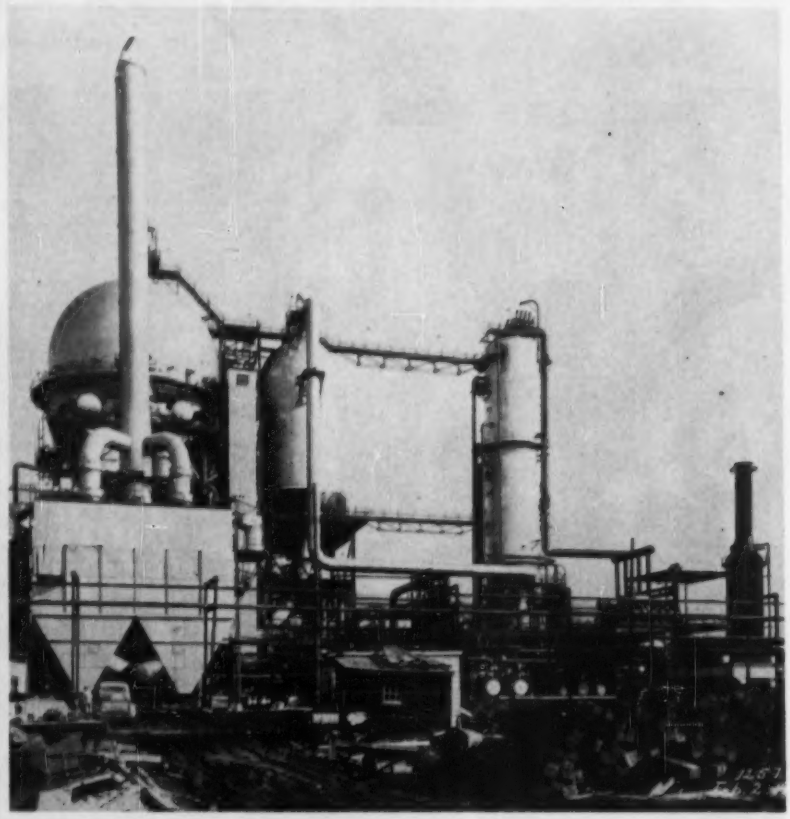


A new 16,000-barrel-a-day fluid catalytic cracking unit at Philadelphia is one of six such units installed at Gulf refineries since the war.

tion needed to keep up with the demand for higher-octane gasolines, small refineries were shut down at Pittsburgh, Pa., and Fort Worth and Sweetwater, Texas. All three of these plants had thruputs of less than 15,000 barrels a day, and one of the Texas refineries had only half that capacity.

Meanwhile major construction projects were underway at four of the larger refineries, at Philadelphia, Port Arthur, Cincinnati and Toledo, and considerable work was being done at the Gulf refinery on Staten Island.

At Philadelphia, Gulf installed three topping and vacuum units, one with a daily capacity of 125,000 barrels, and the others running 32,500 and 27,500 barrels a day. Construction at Toledo included a 32,000-barrel-a-day topping and vacuum unit.

To replace older equipment at Port Arthur, the company installed three new topping and vacuum units, each with a daily capacity of 20,000 barrels, and is building another unit to have a daily capacity of 100,000 barrels. The refinery also has a new 26,000-barrel-a-day vacuum-reducing still.

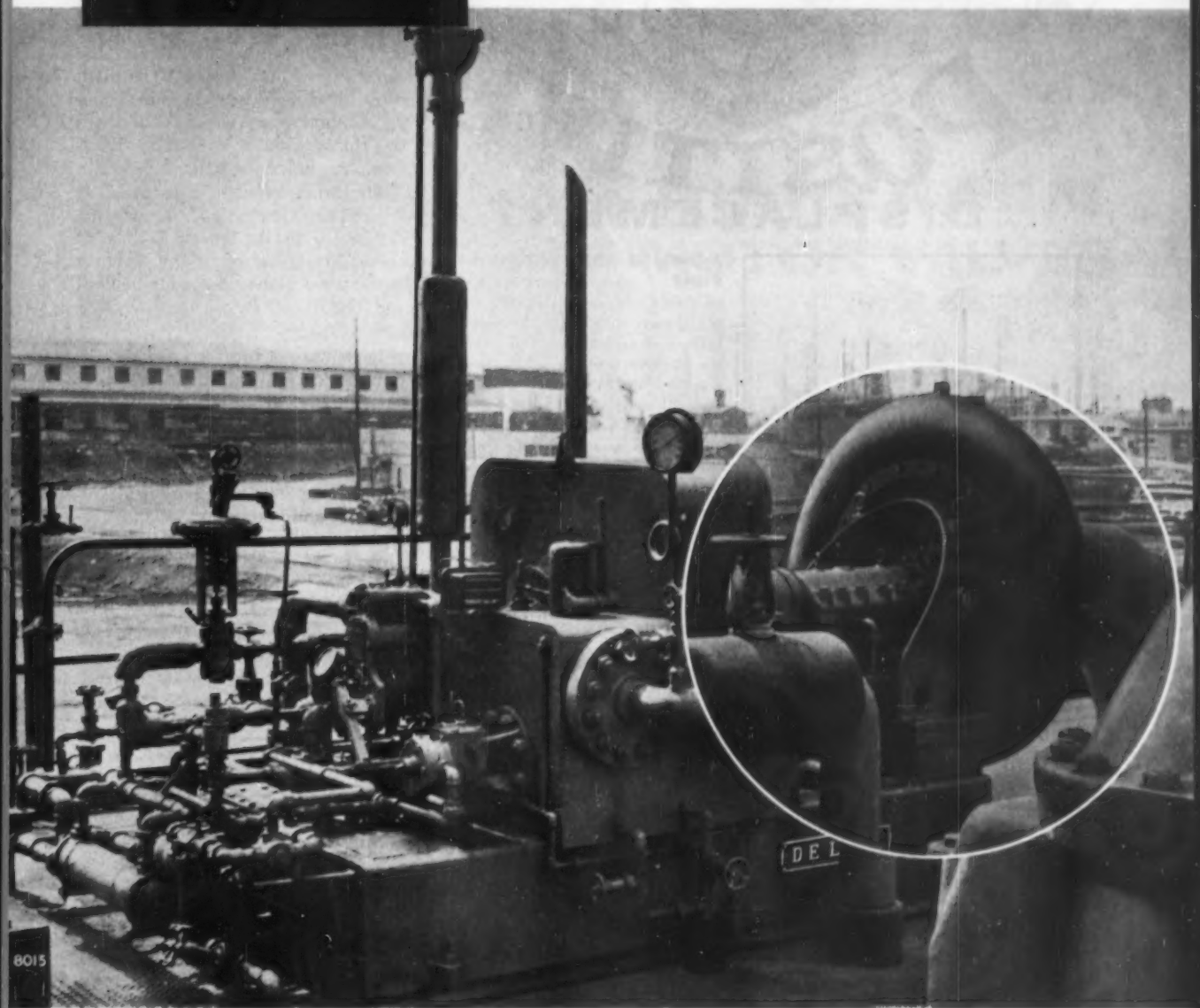
Fluid catalytic-cracking facilities put in since the war gave Toledo and Cincinnati new units built for a daily capacity of 15,500 barrels each. At Philadelphia, two units were installed with a combined capacity of 84,500 barrels, and 63,500 barrels of new cracking capacity went in at Port Arthur. An additional 68,500-barrel-a-day unit is under construction at Port Arthur.

Gulf recently went on stream with a new 29,000-barrel-a-day catalytic-reforming unit at Port Arthur, marking the end of a program that called for reforming equipment at all four of the larger refineries. At Philadelphia, the company put in a 16,000-barrel-a-day unit, and 10,000-barrel-a-day units went in at both the Ohio refineries.

Additional postwar capacity was

DE LAVAL
CENTRIFUGAL
BLOWER

controls air in cat cracker at Standard Oil of California



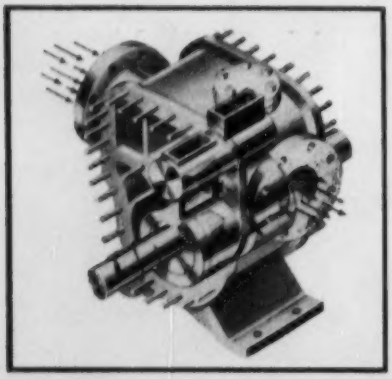
This De Laval centrifugal blower, selected by the Fluor Corporation, is on stream at the Standard Oil Company of California's new cat cracker in El Segundo. For control air service, this blower delivers 9,500 cfm; inlet pressure is 15.4 psig and discharge pressure 19.4 psig. The blower is driven by a De Laval 220 brake horsepower MCP Turbine operating at 800 psig with a temperature of 650 F; it has all labyrinth shaft packing for high back pressure service.

In addition to single stage designs, De Laval makes a complete line of equipment for all refinery services, including multi-stage compressors driven by De Laval multi-stage turbines for condensing, non-condensing and automatic extraction applications.

Send for new Bulletin 0504

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey



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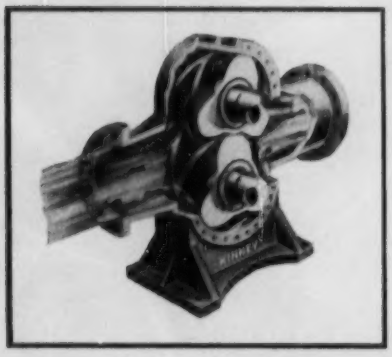

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As Management Sees It . . .

gained by the 1949 and 1950 completions of two foreign refineries operated by Gulf affiliates. One of these is the Venezuela refinery at Puerto La Cruz, presently rated for a daily capacity of 55,000 barrels. The plant is operated by Venezuela Gulf Refining Company, in which Gulf owns two-thirds interest and The Texas Company holds the balance.

The other refinery, operated by Kuwait Oil Company, Ltd., at Mina al Ahmadi, on the Persian Gulf, runs about 30,000 barrels a day. Interest in the plant is shared equally by Gulf and The British Petroleum Company, Ltd.

In the way of future expansion, the company plans to install still more new equipment at Philadelphia. It will include a 24,000-barrel-a-day reformer, two Gulfining units totaling 36,000 barrels a day for hydrodesulfurization, a 2800-barrel-a-day alkylation unit and related service and storage facilities as a multi-million-dollar project.

At Port Arthur, the company already can foresee additional millions of dollars in construction which will include a 3800-barrel-a-day increase in alkylation facilities, a 4000-barrel-a-day vacuum rerun unit for lube oils and a 5000-barrel-a-day dewaxing plant.

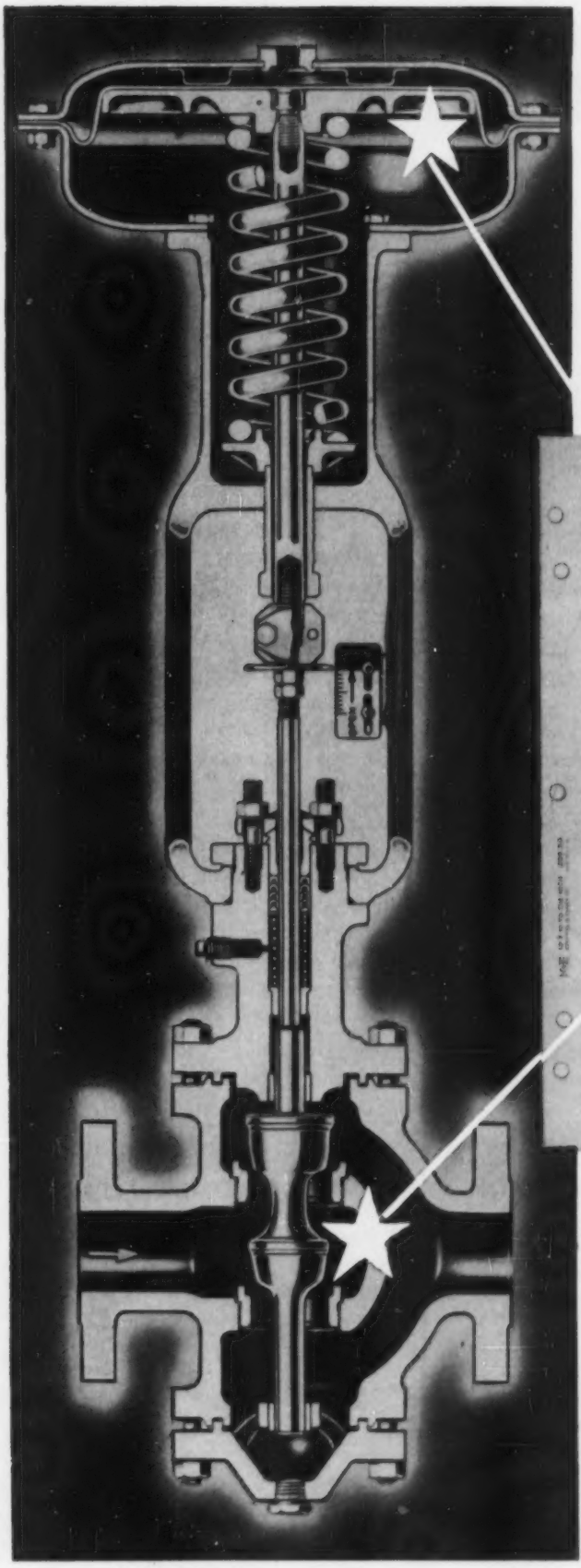
In addition to increasing its refining plant at Port Arthur, Gulf plans to expand its propylene polymerization facilities there, doubling the plant's present 2600-barrel-a-day capacity. Indefinite plans for construction at Port Arthur also include facilities for grease making, compounding, filling and packaging.

In the field of petrochemicals, the affiliated Goodrich-Gulf Chemicals, Inc., plans to build a pilot plant to produce a new synthetic rubber at Avon Lake, Ohio. Now in the planning stage, the $750,000 installation is expected to be in operation in less than a year.

The company, owned jointly with The B. F. Goodrich Company, has developed a process to reproduce the structure of crude rubber. It expects the new rubber at Avon Lake to be practically identical to tree-grown rubber.

The affiliate also expects to expand

811 Nottingham Way, Trenton 2, New Jersey



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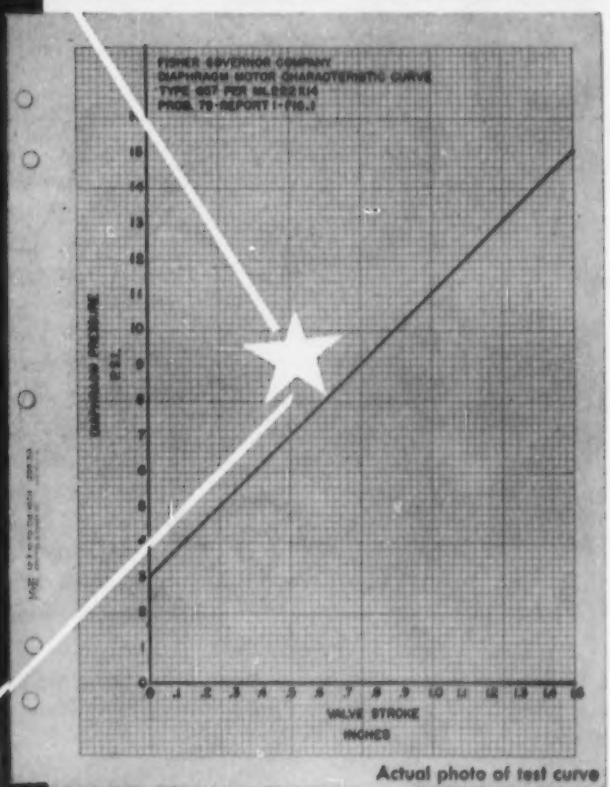
DIAPHRAGM MOTOR VALVES



Actual photo of test curve

NEW SUPER STRUCTURE PROVIDES LINEARITY OF OPERATION

Special molded diaphragm, in combination with deep casing, provides constant diaphragm effective area. Resultant linear relationship between input signal and inner valve position makes *flow versus diaphragm pressure* characteristic of control valve identical to *flow versus lift* characteristic.

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Our 75th
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For more data on advertised products, use Readers' Service Cards, last page.

. . . OF SOUP, SACCHARIN, AND SUDS

What's in a drop of oil? Petroleum chemistry has found the answer to be without limits.

With petrochemicals, great strides have been made in producing better insecticides and pesticides, thereby enhancing the world's food supply. Petrochemicals brought about the successful synthesis of pharmaceutical compounds, making possible the mass production of life-saving drugs. New building materials . . . synthetic fibers and detergents . . . all of these are the results of continued research in the field of petrochemicals.

To make a great part of these successes possible required from petroleum sources the availability of large quantities of high purity benzene, toluene, and xylenes. These aromatics are now produced in exceptionally high purity and large amounts by the UOP Platforming process and are separated by the Udex process, this latter process developed cooperatively by Dow Chemical Company and Universal Oil Products Company and engineered and licensed by UOP. With these processes a ready supply of aromatics will always be assured.

Unheard of only a short time ago, these developments have become just the beginning for an unlimited future.

UNIVERSAL OIL PRODUCTS COMPANY

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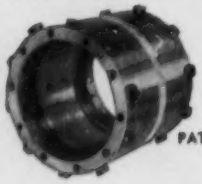
UOP *Universal Service Protects Your Investment*

Safer . . .
Quicker . . .
Pipeline Repairs

Weld+Ends Permits Welding a Pipeline While Pumping Through It.

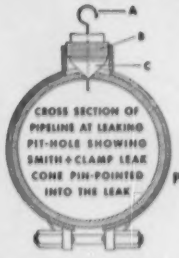


PATENTED

A pipeline safety welding coupling for crude oil, gas, gasoline, asphalt, steam, chemical process and other pipelines. WELD+ENDS joins pipe securely so flow can be resumed immediately at full pressure. Welding can be performed while pipeline is in use days or weeks later. Sizes 2" to 36".

• • •

Smith+Clamp Permits Plugging and Welding Pit-Hole Leaks in a Pipeline While Pumping Through It.



PATENTED

Smith+Clamp shuts off more easily, quickly and safely than ordinary clamps. Use on high and low pressure gas, gasoline, crude oil, water, steam, air, chemical process and other pipelines. Sizes 1" to 30". Combine with WELD-PLATE when pipe reinforcement is specified.

Write today for complete information on these latest developments in safer, quicker pipeline repairs: Weld+Ends and Smith+Clamp.

The Pipe Line Development Co.

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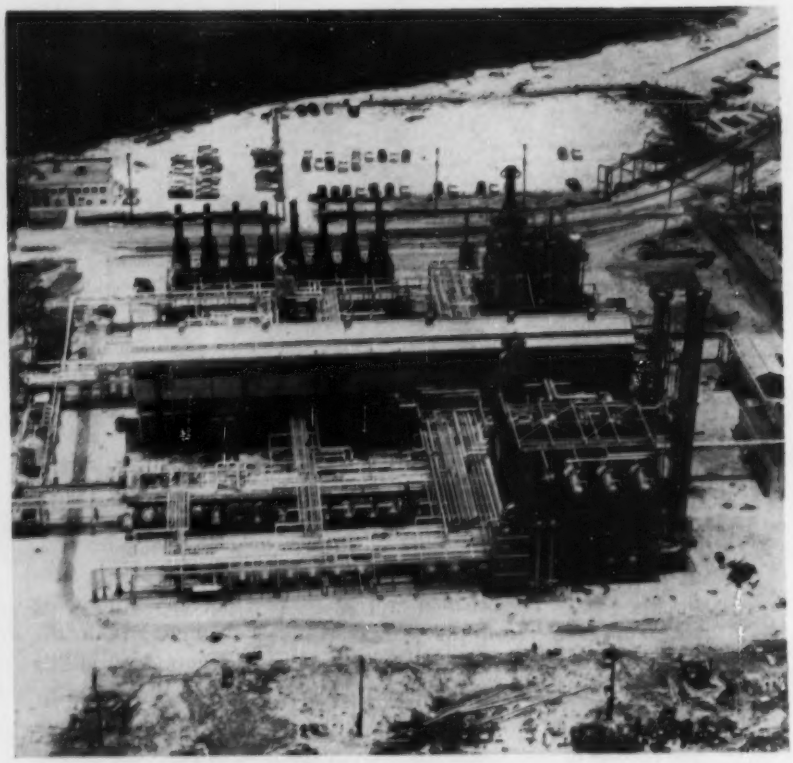
As Management Sees It . . .



Gulf's ethylene plant No. 2, completed this summer, is part of the company's rapid expansion into the petrochemical field. This second ethylene plant has a daily capacity of 666,000 pounds a day. Plant No. 1 was built for 540,800 pounds a day.

its recently-acquired synthetic-rubber facilities at Port Neches, Texas, to include the production of latex. Initial output will run 12 million pounds a year, with the plant geared for further expansion to triple that output.

Goodrich-Gulf paid the government $41,418,618 for its share of the Port Neches facilities, comprising a 50-percent interest in the facilities for producing 200,000 short tons of butadiene a year, owned jointly with Texas-U. S. Chemical Company, and a plant having a rated capacity of 90,000 long tons of copolymer a year.

Gulf has an interest in certain refining facilities operated by Pontiac Refining Company and Chicago Corporation at Corpus Christi, Texas, as well as a recently-completed 10,000-barrel-a-day refinery operated by Caribbean Refining Company at San Juan, Puerto Rico.

The company also is interested in a refinery operated by Esso Standard, S. A., at Port Jerome, France. This plant, completed in 1933 with an initial capacity of 20,000 barrels a day, was damaged during the war and dismantled by the Germans.

It was later rehabilitated, however, and the original capacity has now been almost doubled. Modernization projects, either completed or under construction, cover a 12,400-barrel-a-day fluid catalytic cracker, a 7000-barrel-a-day middle-distillate hydrodesulfurization unit and propylenepoly equipment.

Gulf has a 7 percent interest in the operation of refining facilities at Abadan, Iran. ##

For a Quick Look at news you need to know about what's happening in the industry, see page 91

NEED EXTREME DRYNESS?

ALCOA Activated Alumina dries to lower dew points than other commercial adsorbents

TYPICAL PROPERTIES
OF DESICCANT GRADES ALCOA ACTIVATED ALUMINAS

CHEMICAL ANALYSIS, %	F-1	F-3	F-5	F-6	H-151
Al_2O_3	92	92	77	88	85
Na_2O	0.80	0.80	0.70	0.76	2.0
Fe_2O_3	0.12	0.12	0.10	0.11	0.15
SiO_2	0.09	0.09	0.08	0.08	6.3
Loss on Ignition 1100°C (2012°F)	6.8	7.2	12.4	8.5	6.2
$CaCl_2$	.....	.....	9.3	.....	.....
$CoCl_2$	.....	.....	.....	2.0	.....
PHYSICAL PROPERTIES					
Form	Granular	Granular	Granular	Granular	Ball
Surface Area, meters²/g	210	200	.....	200	350
Bulk Density, Packed, lb/ft³	55	55	60	57	55
Bulk Density, Loose, lb/ft³	50	50	55	52	52
Specific Gravity	3.3	3.3	.....	.....	3.1-3.3
Dynamic Sorption*	13-15	11-13	18-23	13-15	21-23
Crushing Strength†	55	55	.....	.....	60
Pore Volume, ml./g	0.25	0.25	.....	0.25	0.3
Pore Diameter, Å	40	40	.....	40	50
Static Adsorption at 60% Relative Humidity, %	13.0 (Min.)	11.0 (Min.)	.....	.....	20.0 (Min.)

The standard sizes for F grade alumina are ⅛" to ¼", ¼" to 8 mesh and 8 to 14 mesh. Other nonstandard sizes from 2" granules to 325 mesh powder are available. Activated Alumina H-151 is available in nominal ⅛" and ¼" diameter balls.

*Adsorption of moisture at 100% efficiency from air under isothermal conditions at 30°C and 84% relative humidity under dynamic flow of 7.5 cu ft/hr/lb *Activated Alumina—Its Properties and Uses.*
†Method of *Activated Alumina—Its Properties and Uses.*

ALCOA® Activated Aluminas are among the most effective and efficient desiccants available for the dehydration of liquids and gases. Dew points as low as minus 100°F—and even lower—may be obtained, and under normal circumstances, ALCOA Activated Aluminas can be used for an almost indefinite number of drying cycles.

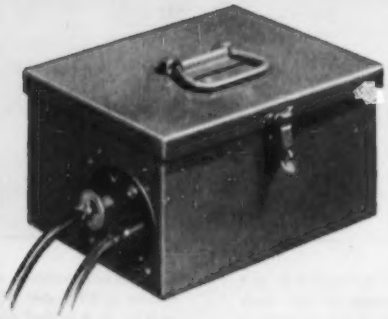
Besides their use for dehydration, ALCOA Activated Aluminas adsorb certain gases and vapors from gaseous mixtures and serve as catalysts and catalyst carriers. They are used in the liquefaction of gases, and for the maintenance of transformer and lubricating oils.

Let us tell you more about these efficient desiccants, and supply you with samples. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-M Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

For more data on advertised products, use Readers' Service Cards, last page.

THE ELLIOTT ELECTRICAL CONTROL



Get tight, uniform tube joints everytime and get them fast. The Elliott Electric Control, a torque-limiting device designed for use with any standard tapping motor, automatically balances outside voltage variables (without the need of a separate voltage regulator), controls the torque, and tells you when the tube has been rolled tight.

Speed the operation too with balancer and the Elliott Stabilizer which takes the wobble out of tube rolling. It centers and holds the expander case and cage, allowing operator to keep both hands on the motor. Full details in Bulletin Y-40. Address Elliott Company, Lagonda Division, Springfield, Ohio.

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Y5-6

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

As Management Sees It . . .

How Vunerable Are We?

Continued from Page 102

Ind.; Providence, Rhode Island; and Atlanta, Ga.

Equally vulnerable are the major harbors through which either foreign or domestic oil comes. Despite the tremendous size of most American ports (e.g. New York's port has 770 miles of waterfront), a 40-megaton H-bomb, which it is now possible to construct, could wreak irreparable destruction on key ports such as Philadelphia, Boston, Baltimore, Los Angeles, San Francisco, New York and Galveston. The net effect would be to hinder the ferrying by ocean tankers of crude oil and natural gas liquids to the refinery and from the refinery to the ultimate consumer.

Similarly, railroad tank car service for oil transportation could be impeded by simultaneous nuclear attacks on transport "bottlenecks" such as St. Louis, Chicago, New York, Peoria, Omaha, Memphis, Kansas City, Minneapolis-St. Paul, New Orleans, Buffalo. These cities, with high indices for railway-terminal and junction traffic, could be "bombed out," choking thereby the ordinary flow of crude and refined oil.

Probably the greatest limiting factor on oil expansion is the functional interdependence between the steel industry and oil. Steel is needed for a myriad of production tools and equipment. The hardware required for new plants and petroleum processing facilities depends largely upon steel, 74 percent of whose total annual ingot production is centralized in 10 areas of 25 mile radius. These same areas also account for 82 percent of total iron production and 77 percent of total American coke production. Resulting from the vulnerable concentration of steel producing mills in the U. S. is the sympathetic vulnerability of all industries, such as petroleum processing facilities, which are strongly dependent upon steel products.

Oil production could also suffer adverse derivative effects from the short supply of critical materials used for making steel alloys: cobalt, columbian, nickel, tungsten, tantalum, molybdenum. Although these six elements are high priority items in the national stockpiling program some come from restricted areas. Thus 90 percent of the world's supply of nickel

How to get more for your dollar in stainless steel fittings!

When you specify TUBE-TURN* Welding Fittings and Flanges . . . regardless of type, size or material . . . you can be *sure* you are getting *top value.* Manufacturing improvements which we are constantly making assure not only unsurpassed quality, but economies which are passed on to you.

In TUBE-TURN Stainless Steel Welding Fittings, for example:

Recent advancements in our production techniques have netted important savings, resulting in price reductions. Are you taking advantage of these savings . . . plus the extra values described on the next page?

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.
They meet *all* U.S. piping code specifications.

TUBE TURNS LOUISVILLE 1, KENTUCKY

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DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
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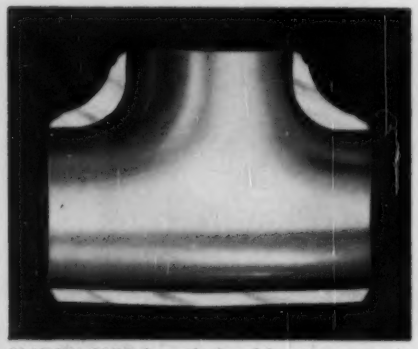
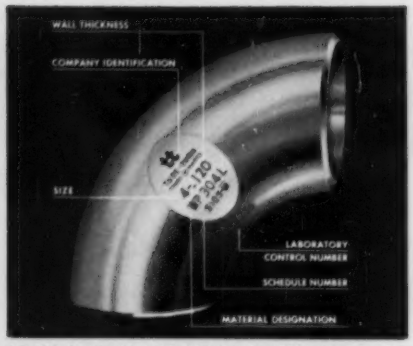
EXTRA VALUES



MATCH PIPE for calculated bursting strength.



LONG-LASTING IDENTIFICATION. Lectro-etch markings give complete, permanent information. Fittings have bright, attractive finish.

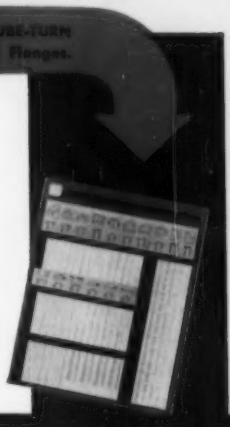
UNIFORM WALL THICKNESS. Pipe minimum wall thickness tolerance of 87½% of nominal thickness is maintained.

TUBE-TURN*
Stainless Steel Welding Fittings and Flanges offer you these extra values

MEET ALL CODES: ASTM A312 (for material); MSS SP43 and ASA B16.9 (for dimensions); MSS SP25 (marking procedure).

COMPLETE LINE IN STOCK . . . four analyses: Type 304, 304L, 347 and 316. Four wall thicknesses: Schedules 5S, 10S, 40S, 80S.

WALL CHART of dimensions of popular sizes of TUBE-TURN Stainless Steel Welding Fittings and Flanges.



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*"TUBE-TURN" and "TT" Reg. U. S. Pat. Off.

TUBE TURNS
A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

comes from Canada. Were these areas to be bombed, petrochemical and petroleum refining processes, not to mention many other large-scale industries, would have productivity curtailed until some alternate element or process was found.

Due to the fact that the operations of the oil production complex are of a continuous-flow nature, automatic controls, instrumentation and servomechanisms are in extensive use. Not only are the petroleum processes "lock-stepped" with automation manufacturers but also with the machine tool and die industry. Geographical concentration of over 54 percent of the production of machine tools and accessories in the Great Lakes area means that, if this region should be successfully H-bombed, the petroleum processing plants would gradually "die on the vine."

Air Raid Destruction in World War II—To appreciate fully the essentiality of petroleum processing in a modern mobilization economy, a consideration should be made of the effects of Allied Air Force bombing upon synthetic oil and petrochemical facilities in Germany during World War II. AAF offensives started against oil and nitrogen plants in May and June, 1944. Within six months of the beginning of the attack on oil, the output of aviation gasoline and nitrogen had fallen by 90 percent, and that of oil products other than aviation gasoline was cut in half. The oil attacks were particularly damaging on military operations due to the diminished oil stocks on hand.

Planned programs of dispersal and underground installations for oil plants came too late in the German defense effort. Besides hydrogenation plants, due to their size and complexity, did not lend themselves to underground locations. Oil, so essential for the German panzer divisions and Luftwaffe's conventional-type aircraft, was a contributing factor in the rapid decline of Germany's mobilization.

What We Learned From World War II—The U. S. can learn a valuable lesson from Germany's experience in World War II. Like Germany, this nation has a highly technological economy which is sorely dependent upon petroleum refining and petro-

A good example of our
WELDING
TECHNIQUE
in connection
with high
alloy casting
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DURALOY
This tube support is 21'6" long; 6'7" wide and weighs 8900 pounds. It looks like a single casting. Actually it is made up of three sections welded together in zig-zag strips across the face. It's a Duraloy HH casting destined for an oil refinery cracking still.
Welding is assuming greater and greater importance in the production of high alloy castings. Often it is the only way to produce large tonnage or unusually shaped pieces. During our many years of experience in producing both high alloy static and centrifugal castings, we have developed sound welding techniques for such castings. Carbon steel welding techniques won't serve. It takes special know-how for chrome-iron and chrome-nickel.
You can rest assured that if the chrome-iron or chrome-nickel castings you order from us require any welding, it will be done skillfully.
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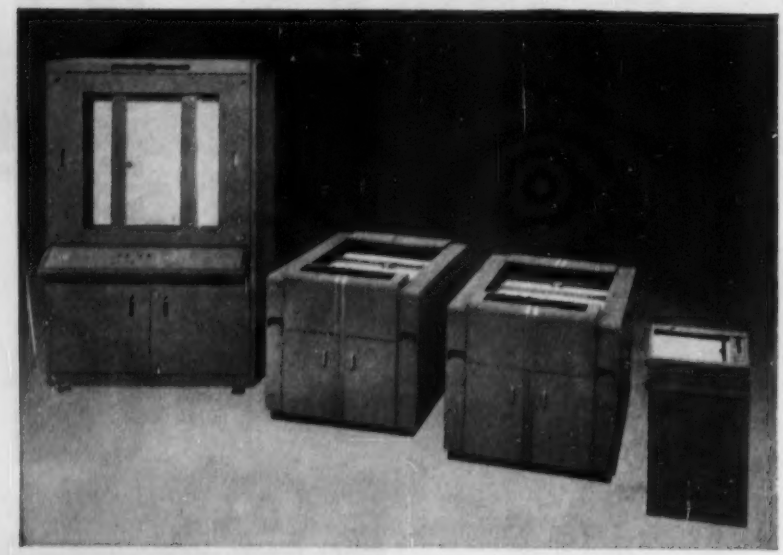
News in Analog Computing...



A choice of Plotting Boards...

A Chicago business analyst reports engineers and industries must have versatility in equipment selection, if they are to carry out the expanded research programs planned for 1956.

Foreseeing this, Electronic Associates is making available the only complete line of plotting boards. Four different models of the famous Variplotter Plotting Board, designed to give a rapid, accurate, graphic recording of any information that can be reduced to electrical form.

Reading from left to right in the picture above, there is the vertical Variplotter, Model 205J, with two arms and four pens . . . the horizontal Variplotter Model 205 K, with one arm and one pen . . . the horizontal Variplotter Model 205L, with two arms and two pens . . . and the latest Variplotter, the Model 1100 A, with one arm and one pen, and featuring small, convenient size, outstanding performance, and low cost.

For detailed information on Variplotter plotting boards, Precision Analog Computing Equipment, or rental of time at the EAI Computation Center in Princeton, New Jersey, contact Dept. PR-14, Electronic Associates, Inc., Long Branch, New Jersey.

ELECTRONIC ASSOCIATES — EAI SETS THE PACE (PRECISION ANALOG COMPUTING EQUIPMENT)

LONG BRANCH, NEW JERSEY

chemical plants; unlike Germany, however, we will not have the opportunity to take counter-measures. The first enemy attack may well be the last.

In the H-bomb era it is very questionable whether this nation or any nation can survive a multi-target nuclear Pearl Harbor. The U. S. has entered both World Wars after European hostilities had begun and the battlefield was clearly on foreign soil. The sanguine expectations of staging World War III anywhere but in our own backyard seem dim in the light of supersonic jet bombers, intercontinental electronically-guided missiles and thermonuclear weapons of unimaginable destructive magnitude.

A critical look at the U. S.' defense posture makes one apprehensive. Certainly the vulnerability of petroleum processing facilities is great; so too is the vulnerability in other crucial defense-supporting industries such as automobile manufacturing, aircraft, iron and steel, rubber, machine tools, instruments and related products. At present the government is taking defense measures to guarantee maximum immunity from nuclear bombs for America's urban and industrial nuclei. The Strategic Air Command is prepared, in the event of a warning, to "bomb up" for a retaliatory nuclear attack on major Soviet targets. The existing continental perimeter defense system, though constantly improving, is not air-tight Apart from the fact that radar surveillance costs are prohibitive on any intensive scale, search radar is a "line-of-sight" operation dependent upon electro-magnetic impulses which can miss aircraft flying below the earth's curvature or behind a mountaintop. Moreover it is possible to jam radar electronically either through weather conditions or deliberate enemy efforts.

Dispersal A Possible Solution—The different warning lines—the Arctic, the McGill, the Distant Early Warning Line—also have gaps through which Soviet bombers could conceivable thread their way into the heartland and coastal areas of the U. S. Evacuation of cities, even if not "spoofed" by Soviet false alarms, is no remedy for critical industrial and military installations.

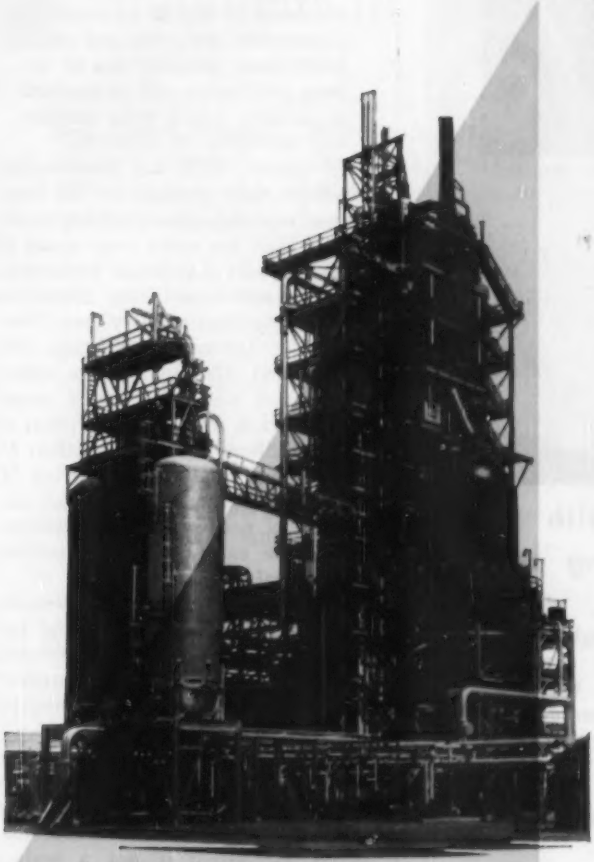
Actually the only feasible solution

This Well Known Billings, Montana, Refinery

uses A. P. GREEN CASTABLE

SK-7 and KS-4

In the Regenerator of its Cat Cracking Unit



SK-7 and KS-4 were used to form a compact monolithic lining in the regenerator of this cat cracking unit at Billings, Montana. In operation over two years . . . it is giving excellent service.

SK-7 and KS-4 offer 4 Outstanding Advantages . . .

1. Cuts construction time and labor costs.
2. Reduces rebound loss.
3. Is adaptable to a variety of installations.
4. Results in linings with balanced characteristics of poured castables.

A. P. Green SK-7 and KS-4 are two great new castable refractories, offering all the advantages of ordinary castables and, in addition, may be "gunned" in place by means of a cement gun. This fast, simple method of installation lowers construction and maintenance costs.

SK-7 and KS-4 were designed for use in combination. They form a composite monolithic lining and are the answer to the demands for castable refractory and insulating castable linings for unusually shaped equipment — the contour of which does not lend itself to the application of normal pouring castables.

A. P. Green REFRACTORY PRODUCTS

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PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
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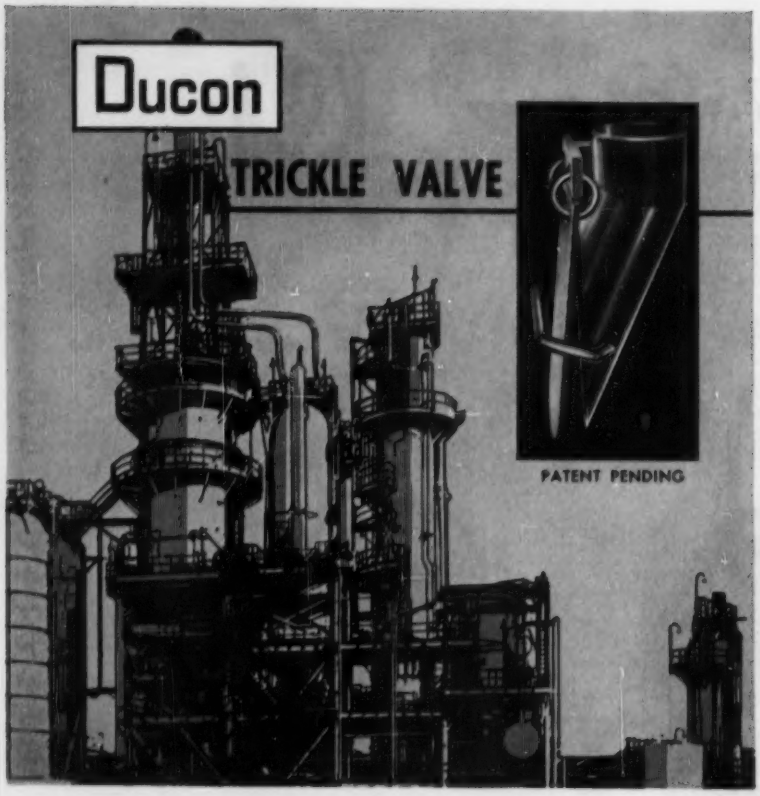
For detailed information concerning these castable refractories, write the Engineering Department of the A. P. Green Fire Brick Company . . . or call your local A. P. Green Distributor.



. . . the first dip-leg SEAL with approval for fluid catalytic cracking plants

Ducon's trickle valve has been *approved* throughout the refining industry, as a "fool-proof" dip-leg seal. Here is the result of years of specialized experience . . . the kind that pioneers progress . . . the kind that has earned for Ducon recognition as a leader in the field of catalyst and fluid solids recovery.

Over 500 trickle valves already in service are proving the effectiveness of the following features:

COMPLETELY AUTOMATIC DIP-LEG SEAL
MINIMUM CATALYST LOSS AT START-UP
ASSURANCE OF DIP-LEG SEAL DURING UPSET
ELIMINATES ALL ADDITIONAL AERATION
MAINTENANCE-FREE CONTINUOUS OPERATION

Write for Bulletin

the name in dust control

Canadian Branch: THE DUCON COMPANY of CANADA, Ltd.
275 James Street North, HAMILTON, ONTARIO

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As Management Sees It . . .

is some form of deployment in space. The federal government, for some years now, has recognized this in principle. In August, 1951, President Harry S. Truman promulgated the National Industrial Dispersion Program. It directed that:

". . . . to the greatest extent practicable, certificates of necessity (for acclerated amortization), allocation of critical materials for construction purposes, and emergency loans growing out of defense production will be confined to facilities which meet satisfactory standards of dispersal."

In August, 1952, tax amortization privileges were granted for the location of new defense-supporting facilities at least ten miles from areas of industrial and population concentrations. It was hoped that dispersion might be satisfied in every case. However, the Defense Production Administration allowed waivers where justification was given for a target zone location. With the exception of plant additions totalling less than $5 million and producing less than 50 percent of previous capacity, all certificates of necessity over $1 million, with some exceptions, were subject to dispersal criteria.

As far as the petroleum processing industry is concerned the rapid tax write-off incentive has not introduced any substantial pattern of "scatter" among those facilities which comprise the industry grouping. First of all, attaining mobilization goals seems to have been paramount; dispersal was secondary. Thus if the natural plant location factors were favorable dispersal succeeded; if not a waiver might be granted for justifiable reasons. Secondly, the bulk of the certificates of necessity in the petroleum processing field was processed in the year previous to the requirement of dispersal criteria as a condition for receiving the amortization privilege.

From August, 1952 to January, 1955, the greatest concentration of new-defense supporting facilities was found in the following states:

- Texas—$240,291,464, or 25.4% of all certificates subject to dispersal criteria.
- California—$134,400,312, or 14.2%.
- New Jersey—$69,439,872, or 7.2%.
- Louisiana—$50,518,445 or 5.3%.

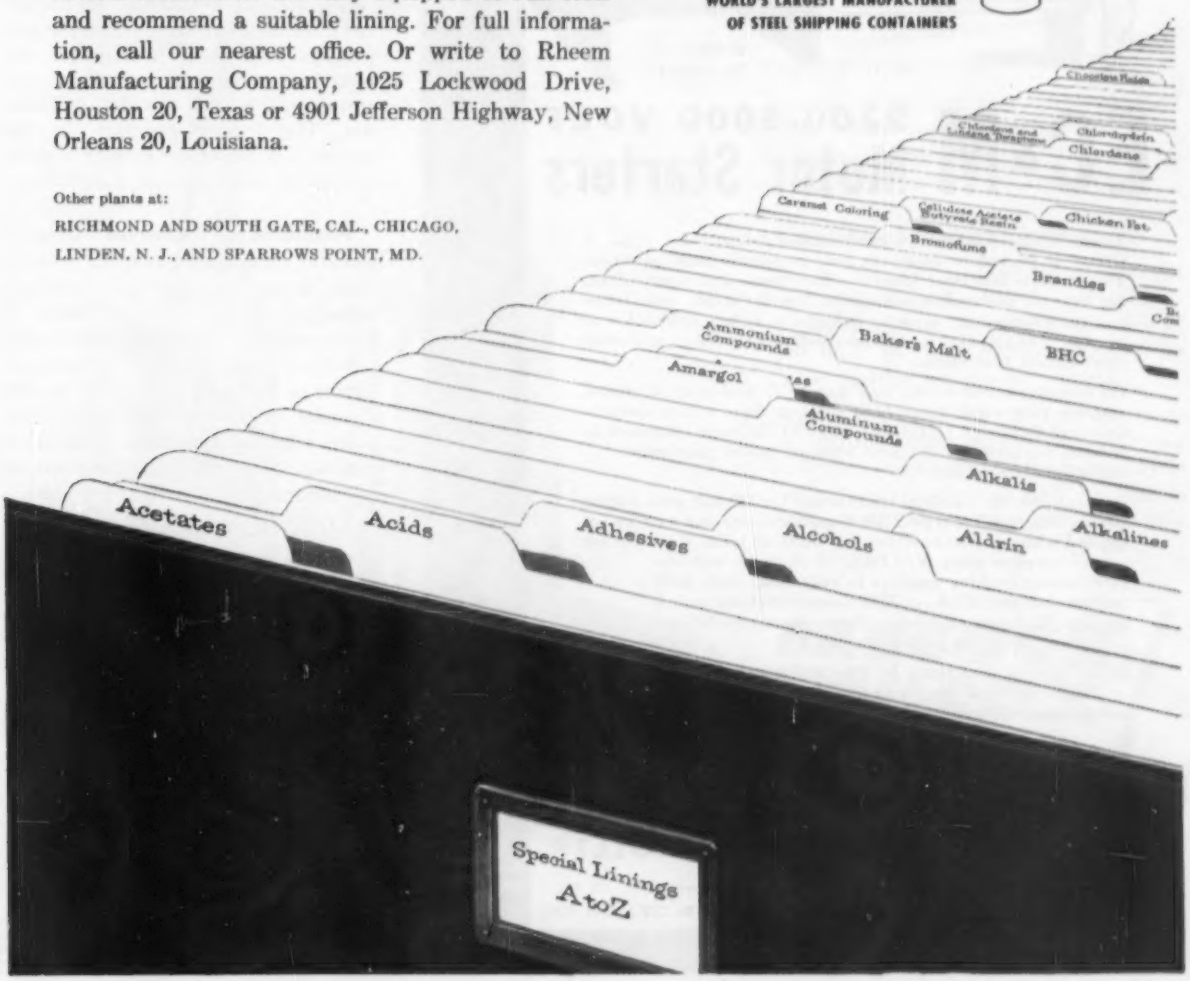
For more data on advertised products, use Readers' Service Cards, last page.

Whatever your product, chances are that Rheem has already developed special linings to protect it for shipment in steel drums

Rheem's experience with hard-to-package products is a matter of record. From acetates to white oils, virtually any bulk-packaged product you can think of is now being shipped in Rheem-built steel drums and pails with special linings.

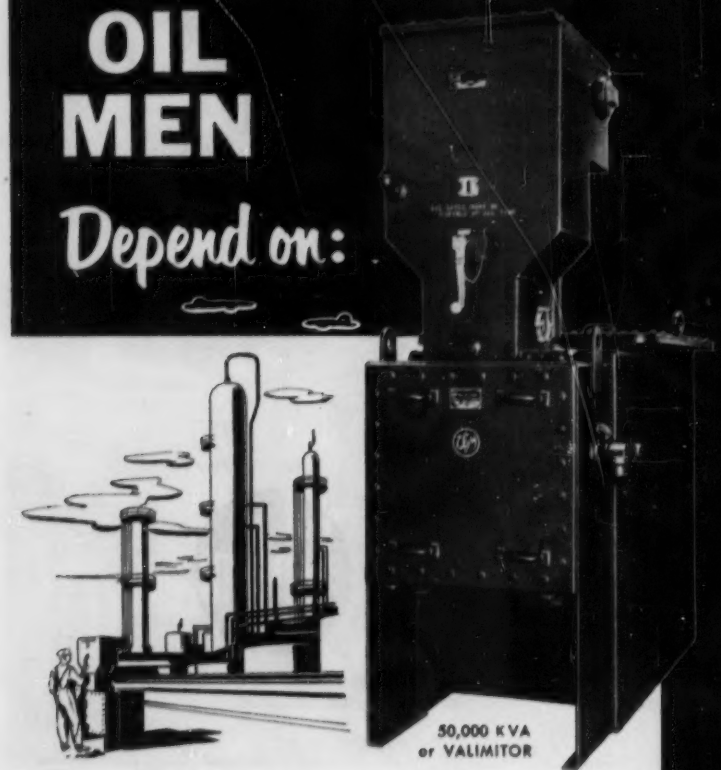
So you name it. If you have a product you'd like to ship in steel containers, chances are that we've already developed a lining that will protect it. If it's a new product, or one that we've never handled, Rheem laboratories are fully equipped to run tests and recommend a suitable lining. For full information, call our nearest office. Or write to Rheem Manufacturing Company, 1025 Lockwood Drive, Houston 20, Texas or 4901 Jefferson Highway, New Orleans 20, Louisiana.

Other plants at:
RICHMOND AND SOUTH GATE, CAL., CHICAGO, LINDEN, N. J., AND SPARROWS POINT, MD.



For more data on advertised products, use Readers' Service Cards, last page.

OIL MEN Depend on:



EC&M 2200-5000 VOLT Motor Starters

These EC&M Division 1 combination Starters for Class I, Group D hazardous locations give petroleum men top-value. They require less floor space . . . line, motor and control leads are brought to conduit connection box for quick installation . . . and interrupting capacity is high . . . either 50,000KVA or in the VALIMITOR (volt-ampere-limitor) type, unlimited short circuit protection.

Oil disconnect switch (on top) may be locked open or closed, and has view windows on both sides to show switch contacts. Overload Relays of THERMAL-MAGNETIC type (mounted in conduit connection box) give accurate motor protection . . . trip instantly on faults.

Rear oil-tank has potential transformer for 220-volt push button circuit. 50,000 KVA type ZHS Magnetic Contactor may be inspected without disconnecting any bolts or leads. Contacts are copper tungsten alloy. VALIMITOR Starters, with air-core current-limiting reactors in rear tank, limit fault current to 25,000 KVA . . . ZHS Contactor clears circuit quickly. No fuses, no need to figure short possibilities . . . supply bus can be infinite KVA.

Before buying, investigate EC&M Combination Starters . . .they provide economy in installation, operation and maintenance . . . and they're complete in every respect.

1915

Write for 16-page Booklet 1062 on EC&M 2200-5000 volt starters.

THE ELECTRIC CONTROLLER & MFG. CO.

4498 LEE ROAD, CLEVELAND 28, OHIO

As Management Sees It . . .

One of the anomalies of the program is the fact that the Office of Defense Mobilization considers Houston for purposes of certification as a dispersed site. Actually, Houston is probably the largest petrochemical center in the country. (See Figure 1). This city alone accounted for 5.4 percent of the total defense expansion in the U. S. in petroleum processing for the period from August, 1952 to December 31, 1954. We have already seen that one-half of the combined investment in all Gulf Coast petroleum processing facilities is within a radius of 60 miles of Houston. Yet the federal government has continued unrealistically to offer the incentive of defense contracts and rapid tax write-offs to corporations building new facilities there. Not only is further congestion encouraged by such a practice but the illusion is created that this is dispersal. Thus when the Office of Defense Mobilization publishes that 79 percent of all defense contracts issued to companies for new projects conformed to dispersal criteria it is veiling the fact of product concentration such as exists in Houston. The federal program, in like manner, is fostering greater vulnerability in other critical industries.

Problems of Dispersal—Unquestionably deployment in space presents some ticklish problems for American industry and government alike. A National Industrial Conference Board survey in 1948—entitled "Decentralization of Industry"—revealed no indication of future decentralization policies in the petroleum production complex. One oil executive summed up accurately the reasons for this:

"As far as our company is concerned, the trend is toward centralization rather than the decentralization of plants, that is, our refineries. I believe this is true of the oil industry in general. There are a number of reasons for this, the chief one being that technical development of refining processes calls for new and expensive refining units, and it is more economical to combine plants than it is to build these expensive units at separate, smaller plants."

The economics of petroleum refining are such that expansion

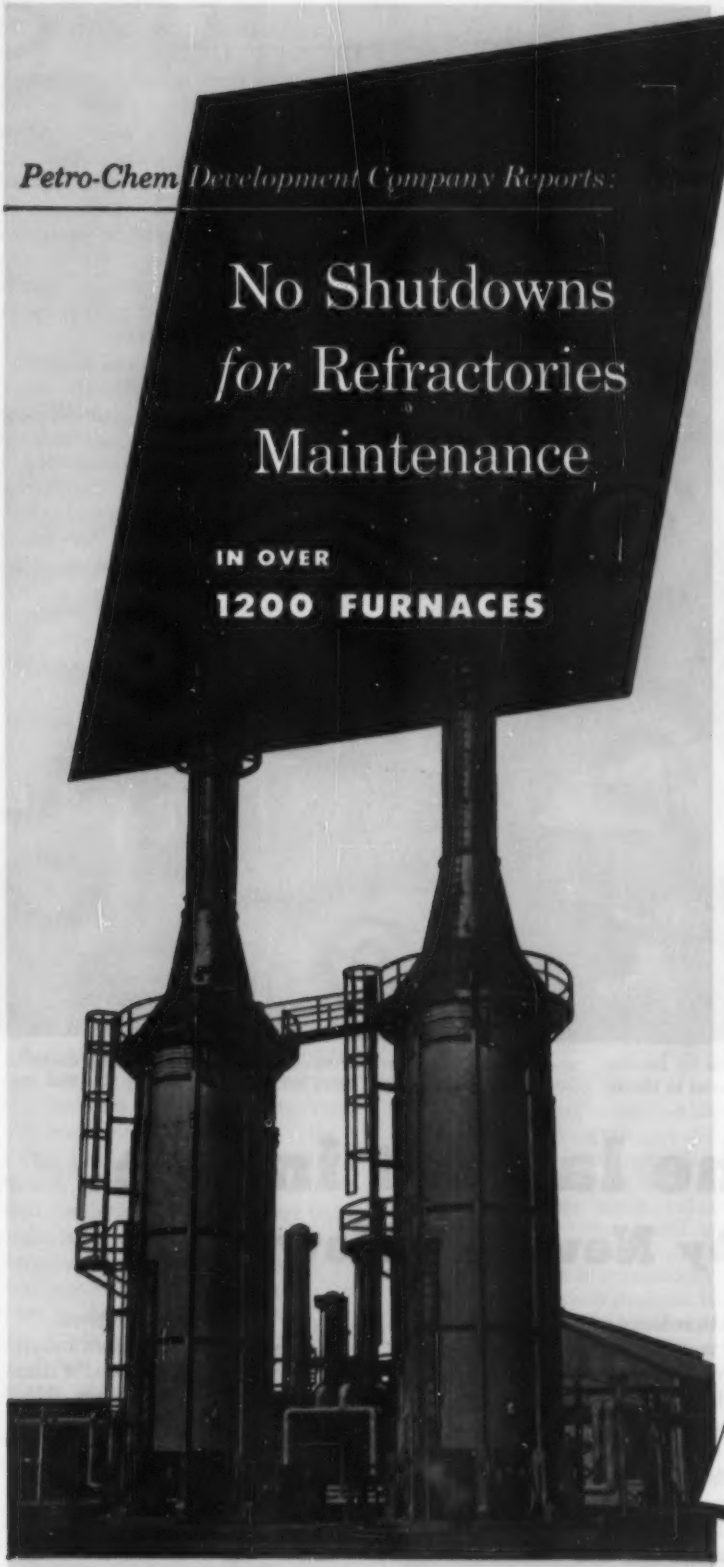
For more data on advertised products, use Readers' Service Cards, last page.

Petro-Chem Development Company Reports:

No Shutdowns *for* Refractories Maintenance

IN OVER

1200 FURNACES



In 1940, the Petro-Chem Development Company lined their first Iso-Flow furnace with B&W Insulating Firebrick. Today, over 1200 installations later, (some with fluid outlet temperatures over 1600F) not a single furnace has ever been shut down because of the need for refractory maintenance.

Long life is just one reason furnace builders, as well as furnace operators, insist on B&W IFB. Here are four more:

CUT INSTALLATION COSTS

B&W Insulating Firebrick are easy to install. They can be cut, drilled or shaped on the job with ordinary woodworking tools. Their lightness makes them easy to handle.

ELIMINATE EXPENSIVE ALLOYS

Because of their high insulating values, B&W Insulating Firebrick can be supported or anchored with ordinary carbon steel. Expensive, heat-resisting alloys are not necessary.

REDUCE DOWN-TIME

These brick have low heat storage, cool off quickly. This makes possible quick access to the furnace for inspection. They heat up quickly to get back on the line, too.

CLOSE TEMPERATURE CONTROL

Due to the low heat-storage capacity of B&W IFB, their hot-face temperature responds quickly to changes in the rate of heat input to the furnace — insuring the closest possible temperature control.

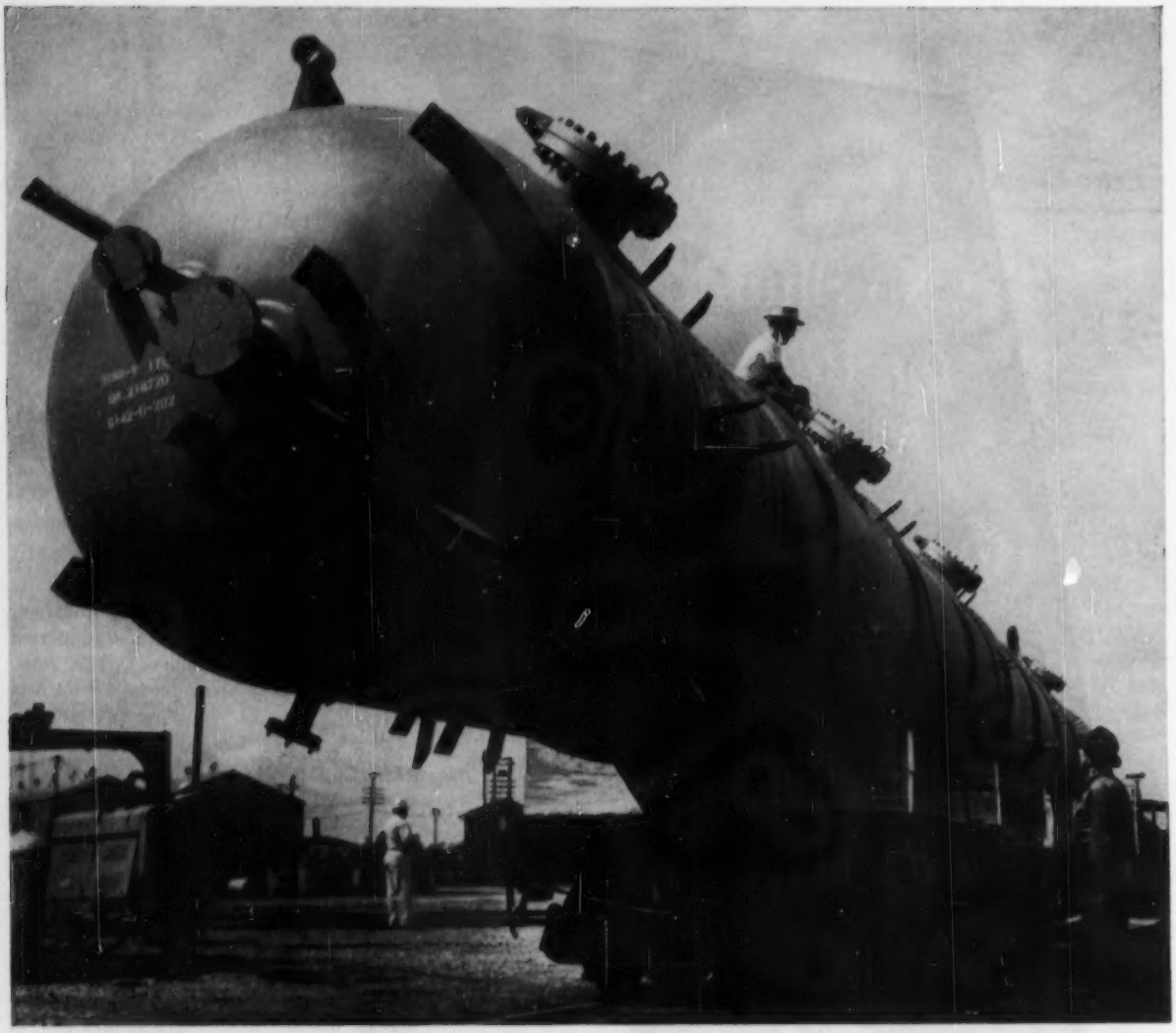
You, too, can profit by this four-way economy of B&W Insulating Firebrick. Ask your B&W representative for all the facts on these cost-cutting refractories. He'll be glad to discuss your refractory problems with you.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS — **B&W Allmul Firebrick** • **B&W 80 Firebrick** • **B&W Junior Firebrick** • **B&W Insulating Firebrick** **B&W Refractory Castables, Plastics and Mortars** • OTHER **B&W PRODUCTS**—Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

For more data on advertised products, use Readers' Service Cards, last page.



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...built by Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

Engineers – Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

through integration with existing facilities gives operating economies, lower costs in steel, manpower, utilities, and housing savings that could not be achieved through the erection of completely new units. Nevertheless some practical measures are urgent if the present inviting vulnerability of this essential production complex is to be mitigated at all.

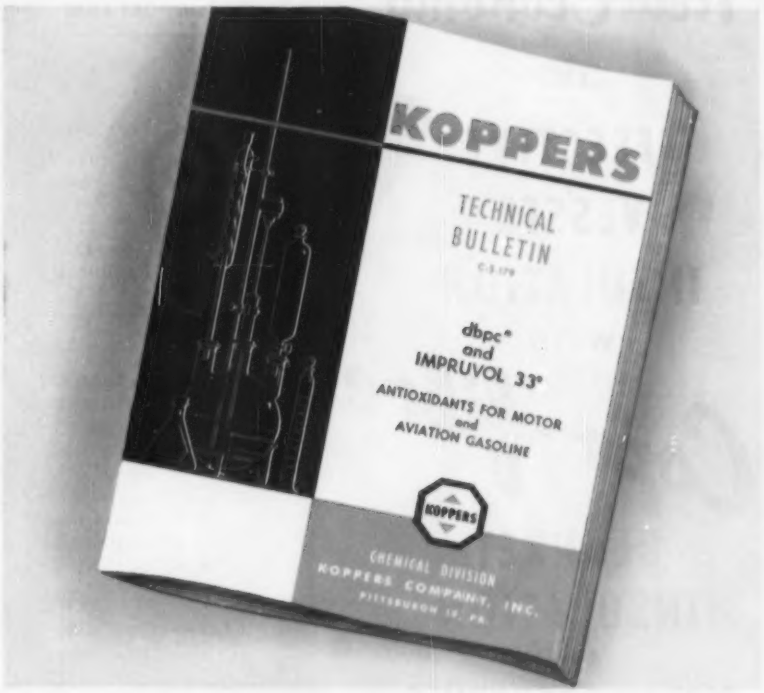
Project East River Report—In its report three years ago, the Project East River committee recommended satellite industrial developments at safe distances from the core area and from one another. The biggest objection, obviously, to such a plan would be the competitive disadvantages and increased costs of such satellite locations. To offset the disincentives involved, the Project East River Report proposed the following inducements:

1. Federal aid to urban arteries, especially those connecting satellite towns.
2. Rent subsidies for a period of time to firms choosing dispersed sites.
3. Government appropriations to match those of metropolitan planning units.
4. Tax assistance to all new construction in outlying areas, with special regard for new and small business
5. Federal loans and grants to satellite municipalities for community facilities (schools, streets, water, sewers, etc.)

The proposals of the East River Project, adopted in some practicable form, could help to deploy our highly nucleated petrochemical plants and petroleum production facilities. The dual concentration of both in such areas as the Houston-Beaumont area, San Francisco, Los Angeles, Philadelphia is a frightful picture to civil defense planners and military strategists, though it is very appealing to Soviet eyes. It could prove in time, to be an irresistible temptation to the enemy. Though it is clearly not feasible to disperse existing facilities, this nation should not lose the opportunity to de-concentrate new production facilities.

Industrial dispersal is the only serious pre-attack preparation within our reach. ##

Want to improve gasoline quality and reduce treating costs?



Send for this NEW BULLETIN NOW!

This new technical bulletin on **dbpc**® antioxidant (2,6 di-tertiary-butyl-para-cresol) was developed to help the refiner understand more fully the many factors which influence gasoline gum formation and automotive induction system deposits. Much of the data is dramatically revealed through newly designed laboratory equipment which is described in detail. And a new inhibiting practice is outlined for the refiner who wishes to improve gasoline quality while reducing treating costs.

Interesting charts, tables, and effectiveness graphs on **dbpc** antioxidant in use and in storage are contained in the bulletin. Furthermore, actual comparisons are made with different types of inhibitors to prove the efficiency and economy of **dbpc** antioxidant.

• • •

Send for your free copy of this factual, informative bulletin, today. Find out how **you** can make a better gasoline at less cost. Write to:

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-125, Pittsburgh 19, Pennsylvania

KOPPERS **Koppers Chemicals**

SALES OFFICES: NEW YORK • BOSTON • PHILADELPHIA • ATLANTA
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HOW TO GET

New Economy

IN

EFFECTIVE VESSEL INSULATION WITH

Copr-fibre

BLANKET INSULATION AND METAL JACKETING

INSULATION SUPPORT RING
VESSEL SHELL
METAL BANDING
Copr-fibre BLANKET LACED TOGETHER AND LACED TO SUPPORT RINGS
INTEGRAL VAPOR BARRIER ON METAL JACKET
SHEET METAL SHEATHING

Insulating vessels and similar equipment with Copr-fibre Blankets and sheet metal jacketing provides an insulation of *greater efficiency* than can ordinarily be expected — and yet at a *lower cost*. This better method (together with complete materials and application specifications) is explained and illustrated in a highly informative brochure just published. If you have not received one, send the coupon today for your free copy of Bulletin 541.

Copr-fibre Blankets with metal jacketing give these advantages:

- Low initial application cost.
- Higher insulating efficiency.
- Effective weather protection.
- Better appearance.
- Longer vessel life.
- Less repair at lower cost.

MAIL COUPON NOW

48 FORTY-EIGHT INSULATIONS, Inc.
Telephone: AUrora 6-8578
AURORA, ILLINOIS

Yes, send me a copy of 48's Bulletin 541.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

As Management Sees It . . .

Safety Is Dependent On Proper Attitudes

WHAT IS THE general attitude among your people toward safety? Are they convinced that they can get hurt as well as the other fellow? What should be done to improve poor safety attitudes? These are questions of great importance to safety programs.

It is axiomatic that good safety attitudes are essential to safe and efficient work performance. It is also well known that, because of business and humanitarian reasons, our plants and laboratories have a strong and legitimate interest in developing, improving and maintaining satisfactory safety attitudes.

How are proper safety attitudes generated? We realize we were not born with them because we see daily what children require in safety guidance. Yet, we know that somehow we individually acquired sufficient safety education and training to avoid thus far the most disastrous penalties —death. Was it fear, good luck, or wasn't our number up? The superstitious may so believe, but industry can ill afford to rely on the vagaries of superstition.

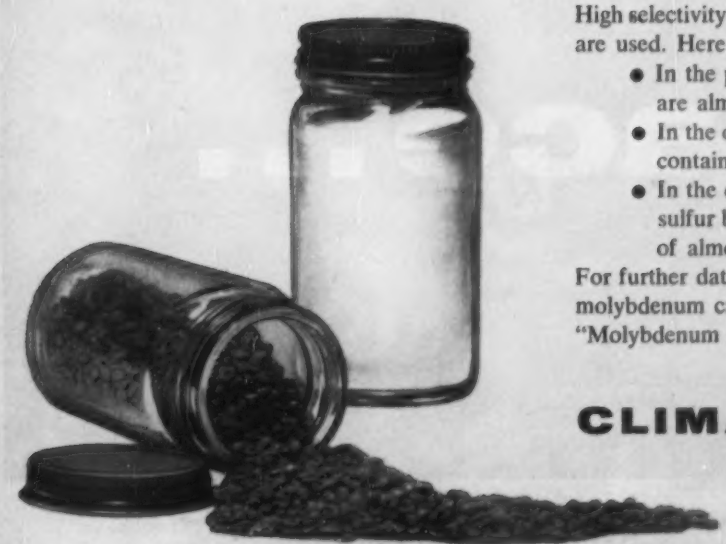
The methods employed by industry to generate proper safety attitudes are based on established facts and include educational training and sales techniques well known to safety men. These techniques aim to cover everyone, from finding safe occupations for new employes, to giving safety training for all jobs to be performed, and to enlisting interest in safety from all leaders, foremen through top management. It is a widely stated belief, that if the line organization really wants safety, they will show they want it and consequently will get it—even though, desirably, no enforcement measures are employed.

The one all-important requirement for the generation of proper safety attitudes is to rank safety as importantly as production, quality and costs.

Our leaders must believe as firmly as safety men do that "the safe way is the right way" and they must participate in company safety programs.

##

Moly catalysts are selective



High selectivity is provided in reactions where molybdenum catalysts are used. Here are three examples:

- In the production of formaldehyde from methanol, yields are almost quantitative.
- In the oxidation of aliphatics to maleic anhydride, the product contains no by-product maleic or fumaric acid.
- In the desulfurization of petroleum stocks, the carbon to sulfur bond is selectively hydrogenated with recoveries of almost 100%.

For further data on these reactions as well as many others using molybdenum catalysts, write Dept. 25 for our bulletin "Molybdenum Catalysts for Industrial Processes."

CLIMAX MOLYBDENUM

500 Fifth Avenue, New York 36, N. Y.

KELLOGG
Sinclair-Baker
Reforming

Dark Horse in the Reformate Race...

New Process and New Catalyst Promise New Records in Production of Low Cost, High Octane Reformates

Although the M.W. Kellogg, Sinclair-Baker process is still too new in service to provide any long-term performance data, and customers' initial findings cannot yet be disclosed, many economic advantages of this catalytic naphtha reforming process have already been firmly established. Any refiner faced with increasing octane yields from present feedstocks, or with getting high octane reformates from lower grade naphthas, will recognize the significance of the following points . . .

Quick Start-Up

Experimental operation is reduced to a minimum. One M. W. Kellogg reforming unit was started on its final test run within two weeks after the catalyst was first charged to the reactors—with octane rating and yield during this 15-day period well in excess of the guarantee.

A Regenerative Catalyst

Sinclair-Baker Platinum Catalyst RD-150 can be regenerated easily and quickly *in situ* to provide many operating cycles, each of many months duration, with negligible loss in catalyst activity. Cost of catalyst per pound in terms of barrels of reformate produced is a major economic factor of the process.

Long Catalyst Life

Sinclair-Baker regenerative catalyst RD-150 has high activity and long initial life. It has been in operation for over one year without supplementing the catalyst. 95 octane reformate can be produced for six months or longer before regeneration is required.

Octane Level

Depending on the feedstock, clear octane ratings above 90 are now being obtained commercially—with 100, and even better, a goal that is entirely feasible and economically practical. *Variability* of octane rating is the keynote of the process, permitting selection of the exact processing conditions for a given naphtha to secure optimum economic operation at all times.

Supply of Catalyst

Use of the process does not obligate refiners to buy Catalyst RD-150 beyond the first year's requirements, although a continuing source of supply can be assured. This freedom from long-term purchase and license agreements is an important consideration when deciding which is the most suitable reforming process.

Low Grade Naphtha Feeds

M. W. Kellogg's unique design permits the effective desulphurization of low grade naphthas as part of the process, and avoids corrosion and metal contamination. Kuwait naphthas thus treated, for example, can produce yields of high octane reformates only slightly lower than those for higher grade Mid-Continent feedstocks.

For More Information

Further details on M. W. Kellogg's catalytic naphtha reforming process, the Sinclair-Baker catalyst, together with some economics of both, are contained in a recent booklet, "Low Cost Production of 95 Octane Clear Reformate." Copy sent on request.

Refinery Process Division

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

The Canadian Kellogg Company, Ltd., Toronto • Kellogg International Corp., London

SUBSIDIARIES OF PULLMAN INCORPORATED

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What's Happening . . .

. . . in the Industry

Defense Department Calls for Dispersal; Sets Broad Policy

The Department of Defense has issued a directive to the three service branches, outlining a policy of dispersal of industry. The directive, expected to affect the awarding of defense contracts, cautions against concentrating critical defense facilities in target areas.

While recognizing obstacles to maximum dispersal, the department has set down four factors to be considered for solution of the dispersal problem. The directive provides:

- Dispersal should be the key factor in selecting additional sources when a number of sources for certain material are available.
- Dispersal should be one of the most important considerations in locating new construction. This would be particularly true when the project receives government aid.
- The services should maintain use of existing facilities until new units are necessary, avoiding excessive cost and social dislocation.
- They should compare the urgency of dispersal with the need for the timely delivery of products.

Avgas Demand Up

Demand for aviation gasoline in the first eight months of 1955 was up more than 4 percent from the same period a year ago. In August, demand held 11.7 percent above the figure for that month in 1954.

According to data furnished by the Bureau of Mines, total exports and domestic demand was 57,616,000 barrels for the eight-month period, as against 55,244,000 barrels for the like period in 1954. In August it totaled 8,162,000 barrels, compared with 7,309,000 in the month a year earlier.

Esso Reseachers Successful In Refining Gasoline by Radiation

Gasoline has been refined by the use of atomic energy. The development was made by Esso Research and Engineering Company scientists, exposing crude oil to gamma radiation from the company's cobalt pipe at Linden, N. J.

The research organization has been experimenting for several months with the effects of atomic radiation on petroleum, chemicals and other materials.

Tests show gasoline can be produced by using radiation under conditions which would not permit its production by other processes. Radiation activates certain types of reactions in the refining process, making them go faster and in a different way.

Esso scientists were unable to determine whether these changes were enough to displace other methods. There were indications, however, that radiation would not completely replace the forces of pressure and catalysts.

Esso's general goal is to learn how gamma rays can make certain chemical reactions more efficiently. The possibility is that radiation will simplify refining operations, cut production costs and perhaps lead to new and improved products.

Scientists already have found indications that radiation of certain materials might produce an additive to improve crankcase lubricants. This improvement apparently extends to the viscosity index.

The company has been running pilot-plant tests in its radiation laboratory. The plant is a small-scale model of commercial refining equipment, set up for adaption to various petroleum and petrochemical processes.

The tests are aimed at finding out if gamma radiation can assist or replace conventional refining forces. If it can be put to work replacing heat, much of the costly heating equipment required by conventional methods could be eliminated.

The next step is for tests to be carried out in large pilot plants producing 100 barrels of gasoline a day. There is no indication of when this will be done, but company spokesmen have said it would be at least six years before radiation could be used in commercial refining.

• • •

Sinclair to Launch Nuclear Research Program

Sinclair Research Laboratories, Inc., will install $250,000 facilities at its Harvey, Ill., laboratories, to use uranium-fission products in the study of refining processes. The new laboratory will use the most powerful gamma radiation in use in any industrial laboratory.

The laboratory, to be completed in 1956, will be equipped to operate with sources having radiation strength of 100,000 curies. This is about 30 times the activity of the most powerful radiation source ever used in petroleum research of this kind.

Gamma radiation will be used in preference to beta rays, because betas will not penetrate the thick walls of the processing vessels. Plans call for the evaluation of a number of commercial-scale processes. They include catalytic cracking, hydrocracking, hydrogeneration and isomerization.

Presidents to Receive Styrofoam Wreaths

A novel use has been developed for Styrofoam. Working with youth groups, Paul A. Vogler, Jr., of Acme Insulation and Service Company in Corpus Christi, has interested young people there in carving the petroleum-derived material into decorations.

To mark the Christmas season, the Corpus Christi group has made large door wreaths for President Eisenhower and former-President Truman. The wreaths were air expressed to Gettysburg, Pa., and to Independence, Mo. One encircles an elephant; the other a donkey.

Operable Refining Capacity Reported by API

The petroleum refining industry expects to have an 8,399,700-barrel-a-day operable refining capacity by the end of 1955. And, according to a survey by the API, this figure is expected to reach 8,582,000 barrels by September, 1956.

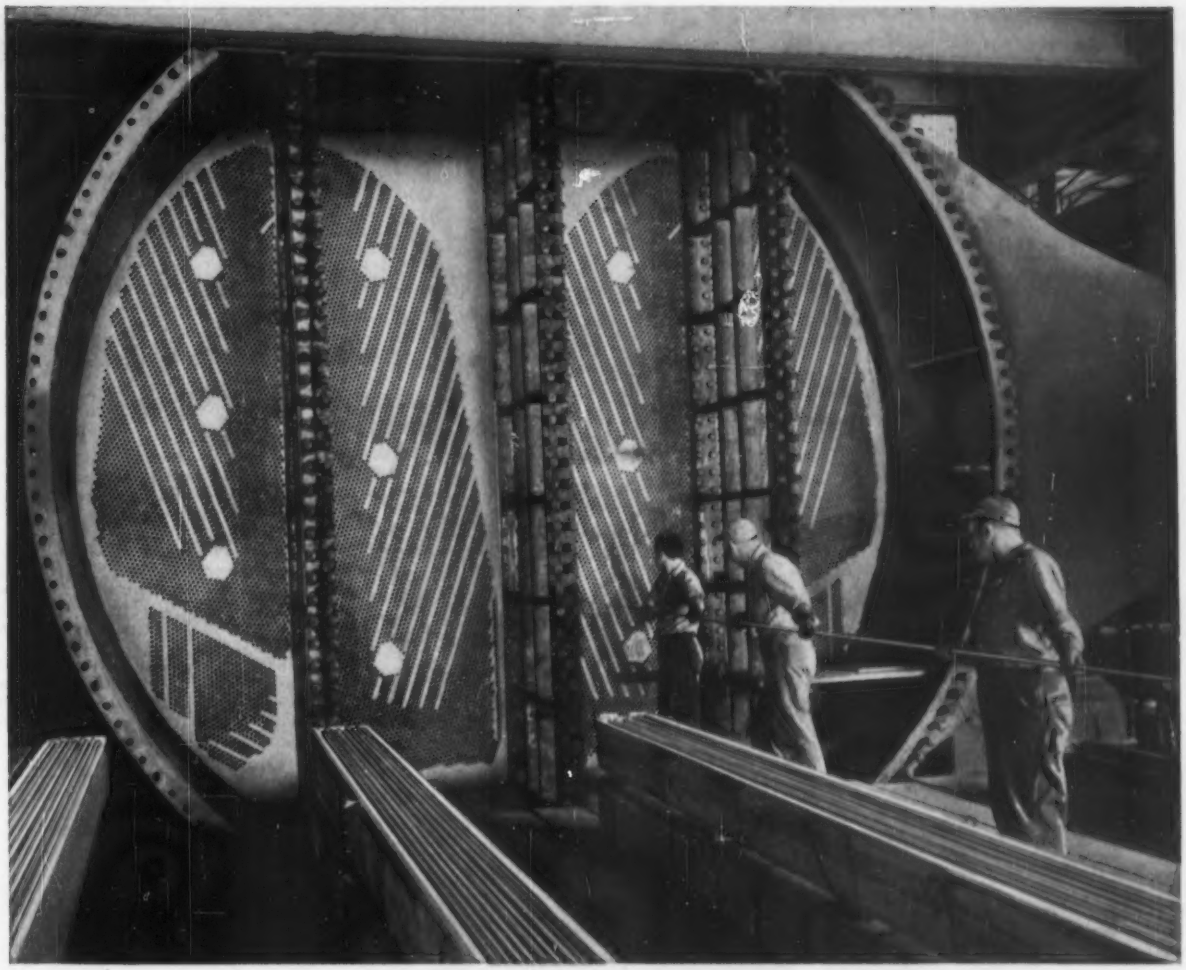
These totals are exclusive of the 135,200 barrels a day capacity which was shut down for major repairs on September 30, 1955. They include, however, 194,700 barrels of capacity which, while operable but

REFINER Index Missing

You may already have noticed that the 1955 PETROLEUM REFINER index is not bound into this issue as indexes have been in the past December issues. On the other hand you may not discover this until you later turn to the REFINER for references to some much needed technical material. In any event, we want you to know that the omission is intentional. This doesn't mean that you have to do without a yearly index to the REFINER. All you need to do is drop a card to the following address:

Librarian
PETROLEUM REFINER
P. O. Box 2608
Houston 1, Texas

So you need not be without this valuable key to the closing year's advancements in petroleum, petrochemicals, and natural gasoline. There is no charge for the index to subscribers of the REFINER.



IN FOR A BIG HEAT-TRANSFER JOB

...AND MANY YEARS OF SERVICE FROM

CHASE® ANTIMONIAL ADMIRALTY TUBE!

Remove 988 Btu's per pound of steam! Condense 1,046,830 pounds of steam per hour! Cool with raw lake water! That's the job of a single-pass condenser for a Great Lakes power and light company.

Tube dezincification is as much a problem in *this* heat-exchanger unit as it is in petroleum refineries. But Chase Antimonial Admiralty was selected for the tubes in this installation with many years of trouble-free service anticipated.

You see, Chase Antimonial Admiralty condenser and heat exchanger tubes have *virtually eliminated* tube failures caused by dezincification. Perfect alloying and tempering provide freedom from season cracking and permit easy rolling into tube sheets. And rigid quality controls at the mill assure tube as flawless as science can make it!

Insist on Chase Antimonial Admiralty!

CHASE WAREHOUSE STOCKS: Houston,* Los Angeles, New Orleans, Tulsa**

*Handled by Standard Brass & Mfg. Co. **Handled by Vinson Supply Co.

Chase

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

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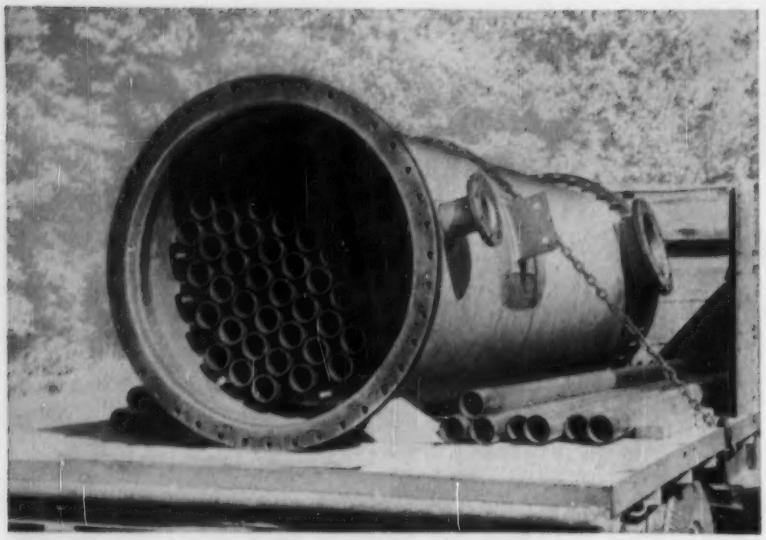
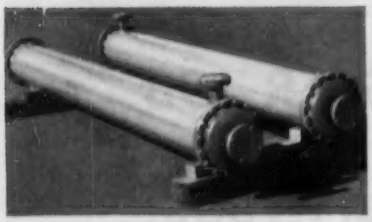
For more data on advertised products, use Readers' Service Cards, last page.

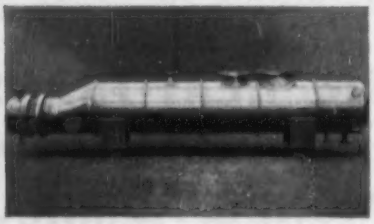


Special heat exchanger materials are well known at Downingtown!

Enamel-Lined Tubes. This stainless steel heat exchanger, with enamel-lined tubes, solved a serious set of problems which included high temperatures . . . heavy corrosion . . . intermittent operation . . . and a tight budget. It now operates at 150% of design capacity, at a temperature of 1200° F.—and the owner reports trouble-free service from his Downingtown unit. Dimensions: 28″ diameter x 10′ 0″ long. Stainless steel shell. Tubes: 3½″ O.D., lined with high temperature enamel.



Ampco 8—Downingtown engineered these two fixed tube sheet benzene condensers for export. Process conditions required copper alloy tube sheets, yet the customer did not want a gasketed joint between tube sheets and shell flanges. So we welded the Ampco 8 tube sheets directly to the steel shells, thus saving the cost of alloy shells. Dimensions: 14″ diameter x 12′0″ long. Eighty copper tubes, 1″ O.D. x 14 gauge. Ampco 8 tube sheets ⅞″ thick. Ampco 8 heads ⅝″ thick. Design pressure is 75 psi on shell and tube sides.



Solid Nickel—This solid nickel reboiler for vacuum service—one of eight identical units fabricated for one customer—was engineered by Downingtown to use a minimum amount of scarce and expensive materials. The double tube sheet construction required special assembly techniques. Notice the large nozzles, which were installed with a minimum of distortion by using proper care and skill during welding. Made of ¼″ solid nickel. Dimensions: 34″ diameter x 17′ 0″ long. Has 292 nickel U-tubes, 1″ O.D. x 16 B.W.G.

We furnish complete thermal and mechanical designs, or fabricate to your plans. Send now for additional information.

Downingtown Iron Works, Inc.

Downingtown, Pennsylvania

New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

DOWNINGTOWN IRON WORKS

Hackney

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What's Happening. . .

believed to be in a high-cost marginal group, also were shut down on that date.

For the country as a whole the September 30 figures include about 314,700 barrels a day represented by crude charged direct to cracking units.

The institute's report, due to appear as Bulletin 59, predicts capacity will hit 8,458,600 on the last of March, 1956; and 8,526,300 by the end of June. Capacity was expected to run 8,399,700 barrels a day on December 31, 1955.

North Dakota Refinery Put Back in Operation

Westland Oil Company has placed on stream its recently-acquired Williston, N. D., refinery. The plant, formerly owned by Williston Basin Refining Company, was returned to service after extensive overhauling.

Westland bought the plant at a public auction to sell the assets of the bankrupt Williston company. Westland submitted the high bid of $150,000. The refinery is capable of running 1500 barrels of crude a day.

It is expected to yield 35 percent gasoline; 12 to 15 percent No. 1 diesel fuel; a similar amount of No. 2 diesel fuel, and 25 to 27 percent No. 5 residual fuel oil. The loss is expected to average 3 percent.

New Tulsa Building To House Shell Offices

Plans are being made for the construction of a new 10-story building in Tulsa which will serve as headquarters for Shell Oil Company's operations in that area.

Construction of the $2-million structure, to be known as the Shell Building, will begin early next year. It is expected to be completed by June, 1957.

A new concern, Sunflower Corporation of Tulsa, was organized to own and operate the building.

Petrofina to Purchase West German Refinery

Cie. Financiere Belge de Petroles, S. A., has agreed, subject to approval by the West German government, to purchase 75 per cent of the stock of Roerbau, GmbH. The principal asset involved in the transaction would be Roerbau's refinery at Mulheim, near Cologne.

Deutsche Purfina is to be operated as a wholly-owned Petrofina subsidiary registered to handle distribution and operate the Mulheim refinery. The plant, with a daily thruput of 350,000 tons, may be expanded.

Agreements Reached To Make Polyethylene

Celanese Corporation of America has secured a license from Phillips Petroleum Company to use its new low-pressure process to manufacture polyethylene materials. This is the second firm to enter a licensing agreement to use the process.

Union Carbide & Carbon Corporation already had entered an agreement, under

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High-Purity Fused Alumina

How can you use it to advantage?

Among the many electrochemically refined materials produced by Norton Company, ALUNDUM fused alpha alumina is one of the most widely useful to industry. Thanks to its inherent properties of hardness, chemical stability and high density, engineers in various fields are finding many new applications for it.

Norton fused alumina is produced in a number of forms. Of these, 38 ALUNDUM* grain has proved particularly successful in applications demanding high purity. Electrically fused from Bayer-processed alumina, this white grain is shown by typical chemical analysis to be 99.49% pure Al_2O_3. It is insoluble in common solvents and extremely resistant to reduction. It is an amphoteric refractory and has high dielectric strength. Other characteristics include:

Melting point	**about 3600°F.**
Specific gravity	**3.94**
Crystal structure	**hexagonal system (rhombohedral division)**
Hardness	**9.0 Mohs' scale**
Index of refraction	**1.76 mean**

Typical Product Applications in which Norton high-purity fused alumina is now working out to advantage are:

For Catalytic Reactions. Norton fused alpha alumina carriers are outstanding for chemical stability and resistance to abrasion and erosion. Available in the form of spheres, rings and pellets they are used both in fixed bed oxidation reactions and as inert, low-density carriers for space filler applications where a low surface area (less than $1 m^2/gm$) is required. Other types of ALUNDUM catalyst carriers having surface areas in the range 5-60 m^2/gm are also available.

In Pebble Heaters. ALUNDUM heat exchange pebbles are giving excellent results in pebble heaters for heating gases above operating temperatures permissible in conventional tube furnaces. Their great resistance to abrasion, impact and repeated heating and cooling make them the ideal heat transfer medium in these devices. Also, their high refractoriness prevents them from the softening and "bridging" together that causes stoppages in the heater's moving bed.

In Thermal Cracking Reactors. Particularly in Wulff Process Generators for cracking light hydrocarbons to produce acetylene gas and Koppers-Hasche Generators for cracking light hydrocarbons to produce a variety of gases and petrochemicals — checkers made of Norton ALUNDUM high-purity fused alumina provide definite advantages. Their excellent heat transfer properties, high refractoriness and resistance to erosion caused by hot gases are important Their ability to withstand the thermal stresses of intermittent operation assures long life. And their purity prevents side reactions with the reacting gases, thus safeguarding product quality.

In Gas Synthesis Generators. ALUNDUM fired shapes are ideal for lining generators of this type. Among the inherent characteristics of Norton high-purity fused alumina that work out very well are: high refractoriness, chemical stability, and inertness that prevents reacting with the contacting atmospheres.

Very many other uses for Norton high-purity fused alumina materials include: pure oxides and sintered refractories, refractory cements, wear-resistant parts, laboratory ware, coatings for rocket and jet plane parts and atomic energy equipment.

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include CRYSTOLON* silicon carbide, MAGNORITE* magnesium oxide, NORBIDE* boron carbide, FUSED ZIRCONIA and many others, including a number still under development. These high-melting materials, which have varied applications in many fields, are also the basic ingredients of the famous Norton Refractory Rx's — refractories *engineered and prescribed* for the widest range of uses.

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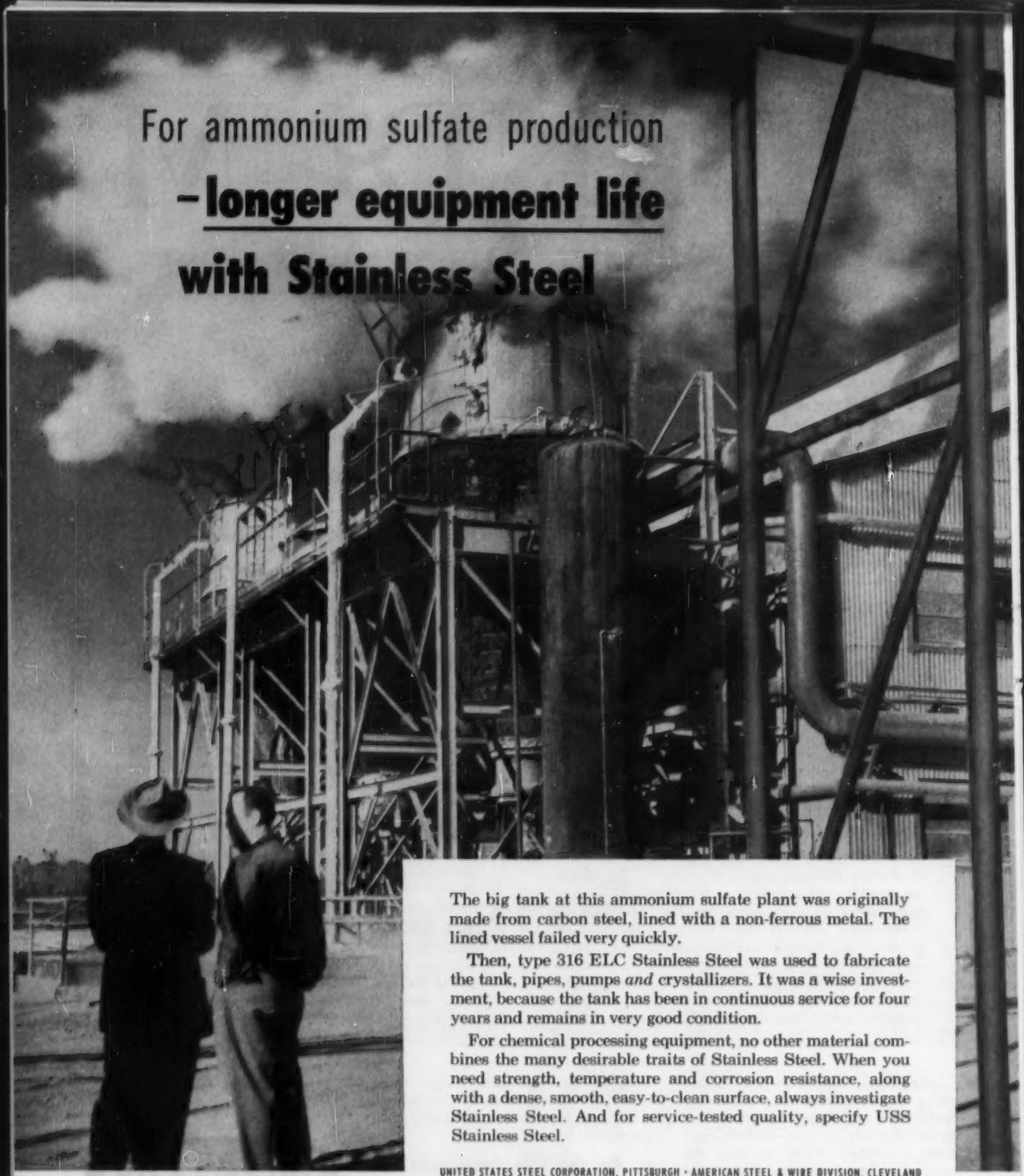

For ammonium sulfate production –longer equipment life with Stainless Steel

The big tank at this ammonium sulfate plant was originally made from carbon steel, lined with a non-ferrous metal. The lined vessel failed very quickly.

Then, type 316 ELC Stainless Steel was used to fabricate the tank, pipes, pumps *and* crystallizers. It was a wise investment, because the tank has been in continuous service for four years and remains in very good condition.

For chemical processing equipment, no other material combines the many desirable traits of Stainless Steel. When you need strength, temperature and corrosion resistance, along with a dense, smooth, easy-to-clean surface, always investigate Stainless Steel. And for service-tested quality, specify USS Stainless Steel.

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which its Bakelite division is licensed to produce certain types of polyethylene. The license cleared Bakelite for production of the types now identified by Phillips' trademark, "Marlex."

Celanese already produces polyesterresins, polyvinyl acetate emulsions and polyethylene sheets and film. It now will begin turning out low-pressure polyethylene.

Predicts Increased Demand For Petroleum Products

Demand for petroleum in the U. S. probably will reach 8.3 million barrels a day in 1955 and go on to hit 15 million barrels in 1975, the president of Sinclair Refinery Company has predicted. Speaking at an Oil-Progress-Week luncheon in Kansas City, J. E. Dyer said the oil industry will spend some $4 billion this year to meet the increased demand. He estimated that by the year's end some $44 billion will be invested in U. S. oil properties and facilities.

Says Public Must Join Fight Against Basin Smog

"The next steps in the fight against smog in the Los Angeles basin are going to be up to the public," according to the chairman of the Western Oil and Gas Association's Air Pollution Control Technical subcommittee.

C. A. Day, who heads Richfield Oil Corporation's Research and Development department said that air-pollution control work, initiated by refineries in the Los Angeles area several years ago, has reached the point where the oil industry is now a minor factor in the situation, leaving automobile exhausts and rubbish burning as the remaining high uncontrolled sources of smog in that area.

Vitro to Buy Treco

Vitro Corporation of America has contracted to buy Refinery Engineering Company at a price reported between $2 and $3 million. The refinery-engineering concern will become a wholly-owned Vitro subsidiary. It will continue to headquarter in Tulsa.

Part of the purchase price will be in common stock of the Vitro Corporation. Treco's annual contracts have averaged in excess of $20 million.

Socony Reorganizes Overseas Operations

A reorganization of the overseas operations of Socony Mobil Oil Company, Inc., will result in setting up a wholly-owned affiliate, Mobil Overseas Oil Company, Inc. The new company, to operate with a high degree of autonomy, will have assets in excess of $500 million.

The overseas company will integrate and be responsible for all activities of Socony Mobil and its affiliates in the Eastern Hemisphere and Latin America, except for its interest in Standard Vacuum Oil Company, interests within major Middle East concessionary areas, and producing operations in Venezuela, Colombia and Peru.

With its affiliates, the new overseas company will have about 25,000 employes;

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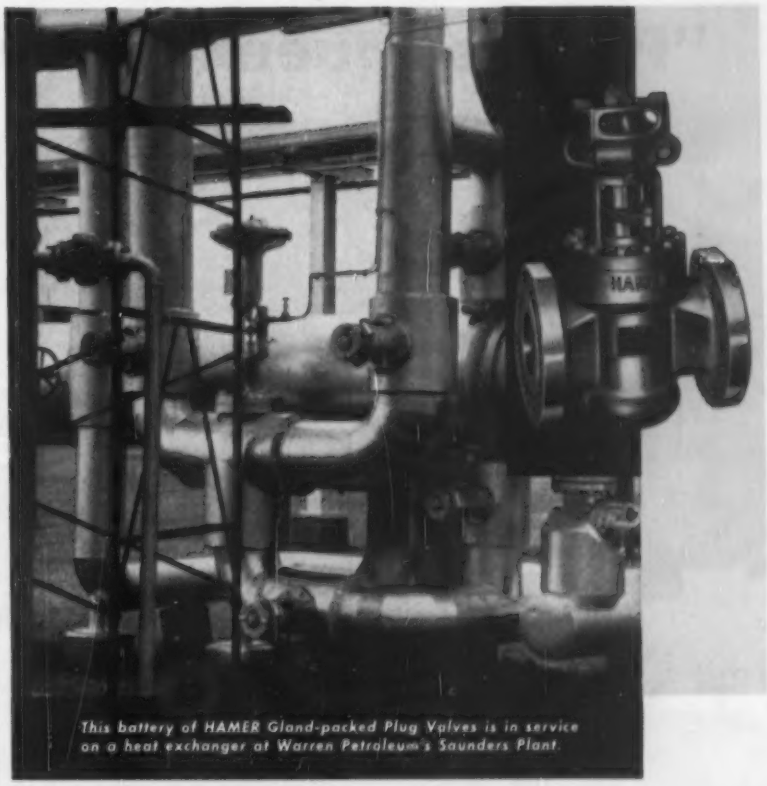

This battery of HAMER Gland-packed Plug Valves is in service on a heat exchanger at Warren Petroleum's Saunders Plant.

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Built for strength and durability, Hamer Line Blind Valves are the modern means of blinding pipe lines quickly and effectively. A one-man, one-minute operation. Cuts costs, and speeds up operations.

Shutting down to change valve packings costs dearly in time and money. That's why Warren Petroleum uses Hamer gland-packed Plug Valves. Not only can Hamer gland-packed plug valves be repacked under full operating conditions, but because of the exclusive plug adjusting nut, a feature of all Hamer Plug Valves, the valves can't stick or freeze. No matter what the time lapse or service you have positive E-Z turn control at all times.

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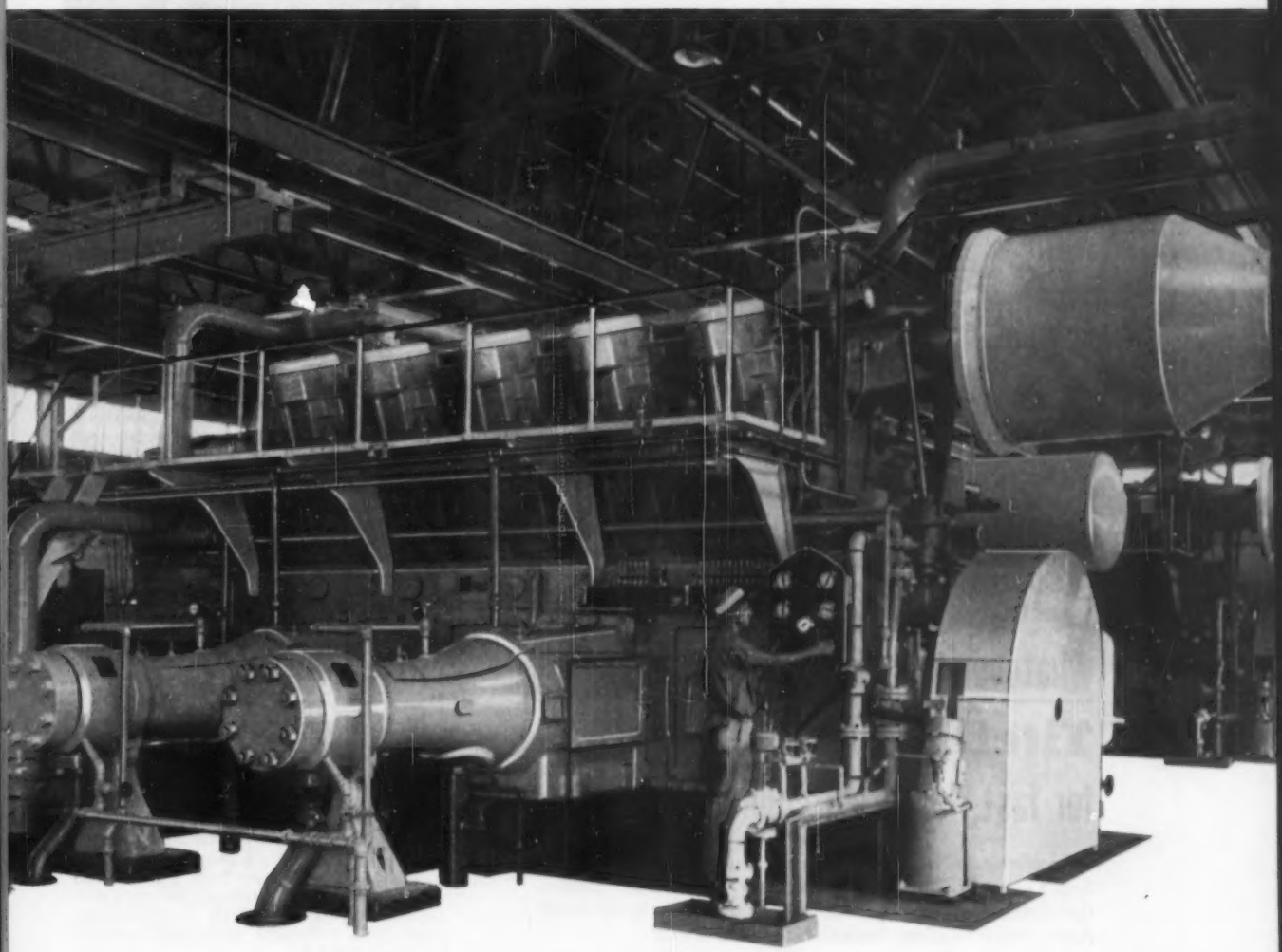

● At Lion Oil Company's $31,000,000 Barton plant near Luling, Louisiana, six 2500 hp Cooper-Bessemer V-angle compressors have gone to work compressing huge quantities of gas for ammonia synthesis.

Operating on a day and night schedule, these engine driven Cooper-Bessemers help produce 90,000 tons of nitrogen a year in the form of anhydrous ammonia and pelleted ammonia nitrate used as fertilizer.

One major feature of the Barton plant is the compactness of compressor equipment. Important reductions in piping, foundations, installation time and building expense are made possible by utilizing only six V-angle units to deliver 15,000 compressor horsepower.

Flexibility to meet varying conditions, durability for continuous operation and efficiency for low-cost performance are three more reasons why so many Cooper-Bessemers are found in similar outstanding plants throughout the nation. The nearest Cooper-Bessemer office will gladly help you select the ideal compressor to best meet your particular needs.

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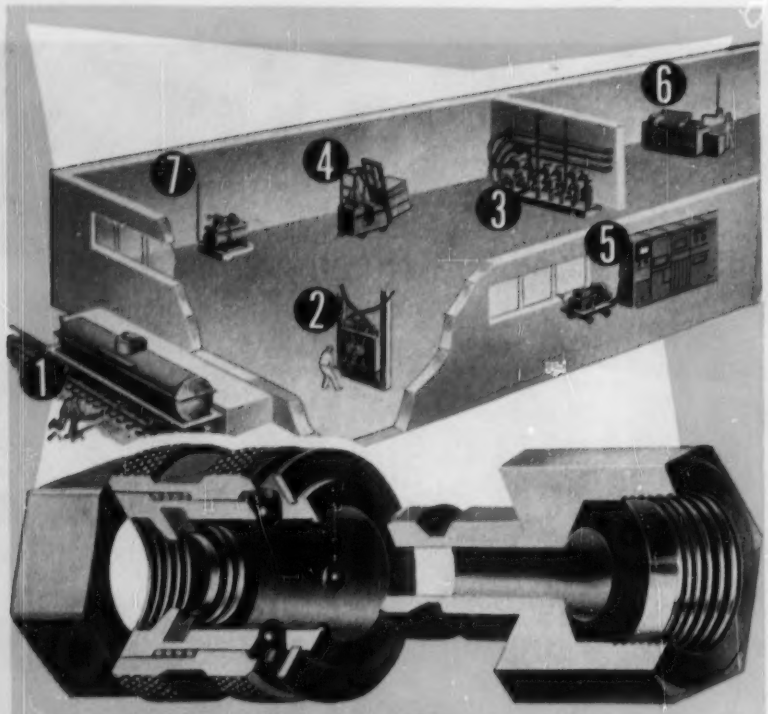

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produce more than 300,000 barrels of crude a day, and operate with a daily refining capacity of about 220,000 barrels. It will maintain a fleet of tankers and carry on marketing operations in Europe, North and West Africa, the Middle East and Latin America.

Headquarters of the new company will be 26 Broadway, New York, until summer 1956, when it will move to the new Socony Mobil Building at Lexington Avenue and 42nd Street. (See Men in Industry).

Shell Awards Contract For Rubber Research

A contract for research on synthetic-rubber manufacturing processes has been awarded by Shell Chemical Corporation to the government laboratories at the University of Akron. Results obtained at Akron will be coordinated with other rubber research projects now in progress at Shell's Torrance, California, laboratory and at Shell Development Company at Emeryville, California.

The research authorized by the contract is expected to be completed by June of 1956.

Gulf Oil Develops New Aviation Lubricant

A new aviation oil, available in four SAE grades (30, 40, 50, 60), has been introduced by Gulf Oil Corporation. The new oil replaces Gulf's aviation engine oil, Series R. and is an entirely new product.

The lubricant is a high-quality, straight-mineral oil, developed from a new blend of crude stocks and refinery processes during seven years of research. It was designed for both radial-and horizontally-opposed aircraft engines.

Awards Fellowship

Celanese Corporation of America has awarded a $2200 fellowship, to study chemical engineering at the University of Oklahoma. The fellowship will permit William E. Brigham, a chemical-engineering graduate from Iowa State College, to pursue studies for a master's degree.

Premium Octane Ratings Reach 96.1 Numbers

Gasoline on sale at service stations in November showed an average antiknock quality, on a national weighted basis, of 96.1 octane number for premium and of 88.8 octane number for regular, according to the latest monthly survey of Ethyl Corporation.

The premium gasoline average was 0.1 octane number higher than in October and 2 octane numbers above the November, 1954, average. The regular gasoline average was unchanged from its October level but 1.7 octane numbers higher than in November, 1954.

Twenty-five of the 53 cities covered by Ethyl's survey reported increases over October in the average octane number of

their premium gasolines, with two cities showing a monthly gain of 0.5 octane number or more. Twenty-two cities reported decreases while six cities were unchanged from October.

In regular gasoline, 27 cities reported increases in their average antiknock quality, eight of them by 0.5 octane number or more. Nineteen cities showed a decrease from October in the average antiknock quality of their regular, while seven cities were unchanged.

Against the nationwide premium average of 96.1 octane number, 18 cities reported premium averages of 96.5 octane number or higher. In regular gasoline, 15 cities showed average octane ratings of 89.5 octane number or higher, compared with the national weighted average of 88.8 octane number.

To Sink Second Cavity For Underground Storage

Gulf Oil Corporation has been 98 to 99 percent efficient in the recovery of LPG from its first underground storage cavity, located near its Waddell gasoline plant in Crane County, Texas. The company was granted a Texas Railroad Commission permit to store excess LPG products in a second cavity on the same lease. This cavity will have a 30,000-barrel capacity.

California Standard Increases College Grants

Standard Oil Company of California plans to award in 1956 more than $100,000 in unrestricted grants to 24 private colleges in the U. S. as a supplement to the broad program of scholarships, fellowships, scientific grants and special services already included in its general program of aid to education.

Program of unrestricted grants will help defray general expenses at the colleges. It does not replace the company's established program of scholarships, fellowships and research grants for specific purposes.

The over-all program of Standard and its subsidiaries for aid to education through fellowships, scholarships, unrestricted aid, technical grants and special services will amount to approximately $1 million dollars. Included in the program are 11 fundamental research projects at eight universities, 43 technical fellowships and 216 undergraduate scholarships at some 100 colleges.

D-X Sunray Refinery Receives Safety Award

The D-X Sunray refinery in Tulsa has received the National Safety Council's Award of Honor. The refinery was one of 14 plants to receive the award of the 834 companies in the petroleum industry evaluated by the safety council.

The award covered the 1954 calendar year operations. During that time, the 1,700 refinerymen at the D-X Sunray plant accumulated a total of 2,695,000 manhours with only three disabling injuries, none major.

Also honored were the refinery's mechanical departments which were presented the Joseph A. Holmes Safety Association Award sponsored by the Bureau of Mines. While this award is presented to any group

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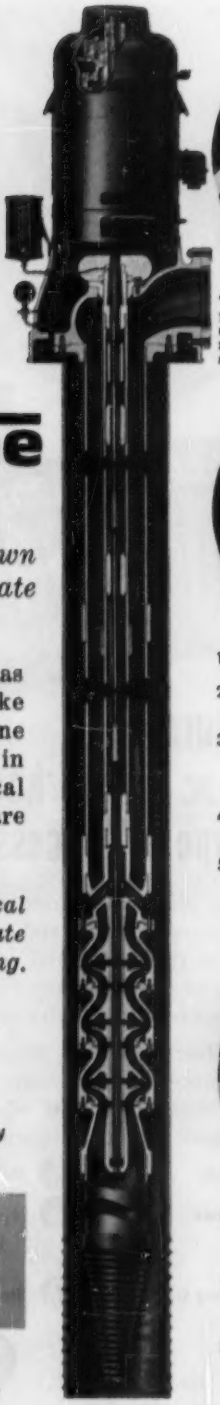
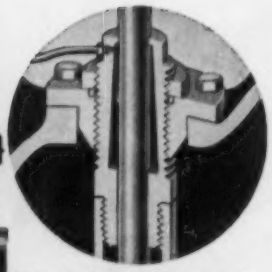
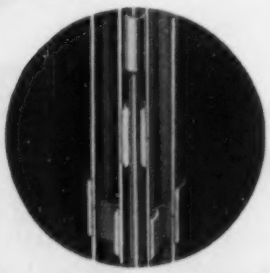




This easily accessible assembly provides means of putting tension on oil tubing, making a rigid, taut, non-vibrating bearing and shaft enclosure.



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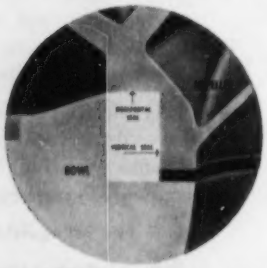
5. Lineshaft is of highest quality steel, turned, ground and polished. Tested for accuracy within .002 in. High tensile strength assures greater safety.



1. Either radial vane or mixed flow type impellers are supplied depending on service and conditions.
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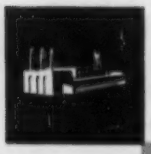

in all industry

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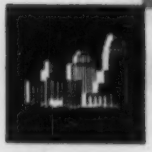

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accumulating a total of 350,000 man-hours without a disabling injury, the D-X mechanical departments won the certificate three-times over with its record of 1,080,000 injury-free man-hours dating from April 28, 1953, through December 31, 1954.

Number of Refineries Down; Thruput Capacity Climbs

The number of petroleum refineries in the U. S. continued to decline during 1954. According to an annual Bureau of Mines survey, there were 326 refineries at the year-end, with a total daily thruput capacity of 8,420,630 barrels. This represents a decrease in the number of refineries by 11 and an increase in thruput of 413,733 barrels.

Additional capacity under construction January 1, 1955, totaled 146,800 barrels a day. This includes four new refineries, one each in California, Minnesota, New Mexico and Washington. In addition, equipment producing 149,550 barrels a day is being replaced. The operating ration of the petroleum refining industry was 87.6 percent at the beginning of 1955, compared with 86.8 a year earlier.

Offers to Buy Refinery

Standard Oil Company of California has made an offer to Pacific Refiners, Ltd., to purchase its Hawaii refining facilities for $2,425,000. Pacific Refiners' directors have approved the sale; it will be submitted to vote by the stockholders. California Standard has not indicated how the purchase would effect its plans for building a $30-million refinery in Honolulu.

ERRATUM

The following references were omitted from "New Tool: Vapor-Phase Chromatography," appearing in the November issue of PETROLEUM REFINER. These references should be added to the "Literature Cited" column on page 169:

[45] Phillips, C. S. G., Disc. Faraday Soc., No. 7, 241-8 (1949).
[46] Phillips, G., J. Sci. Instr., **28**, 342-47 (1951).
[47] Phillips, C. S. G., and James, D. H., J. Sci. Instr., **29**, 362 (1952).
[48] Ray, N. H., J. Appl. Chem., **4**, 21-5, January (1954).
[49] Ray, N. H., J. Appl. Chem., **4**, 82-5, February (1954).
[50] Sullivan, L. J., Lotz, J. R., and Willingham, C. B., Paper presented before the Division of Pet. Chemistry, A.C.S., Minneapolis, Minnesota, September 12-15 (1955).
[50] Tswett, M., Ber. deut. botan. Ges., **24**, 234-44 (1906).
[50] Ibid., 316 (1906).
[51] Ibid., 384-92 (1906).
[52] Turner, N. C., Oil and Gas Journal, **41**, No. 51, 48-52, 69 (1943).
[53] Turner, N. C., Natl. Pet. News, **35**, No. 18, 234-7 (1943).
[54] Turner, N. C., Petroleum Refiner, **22**, 140-4 (1943).
[55] Williams, R. P. J., Analyst, **77**, 905 (1952).
[56] Wirth, H., Monatshefte Fur Chemie., 84, 156-68, 741-50 (1953).

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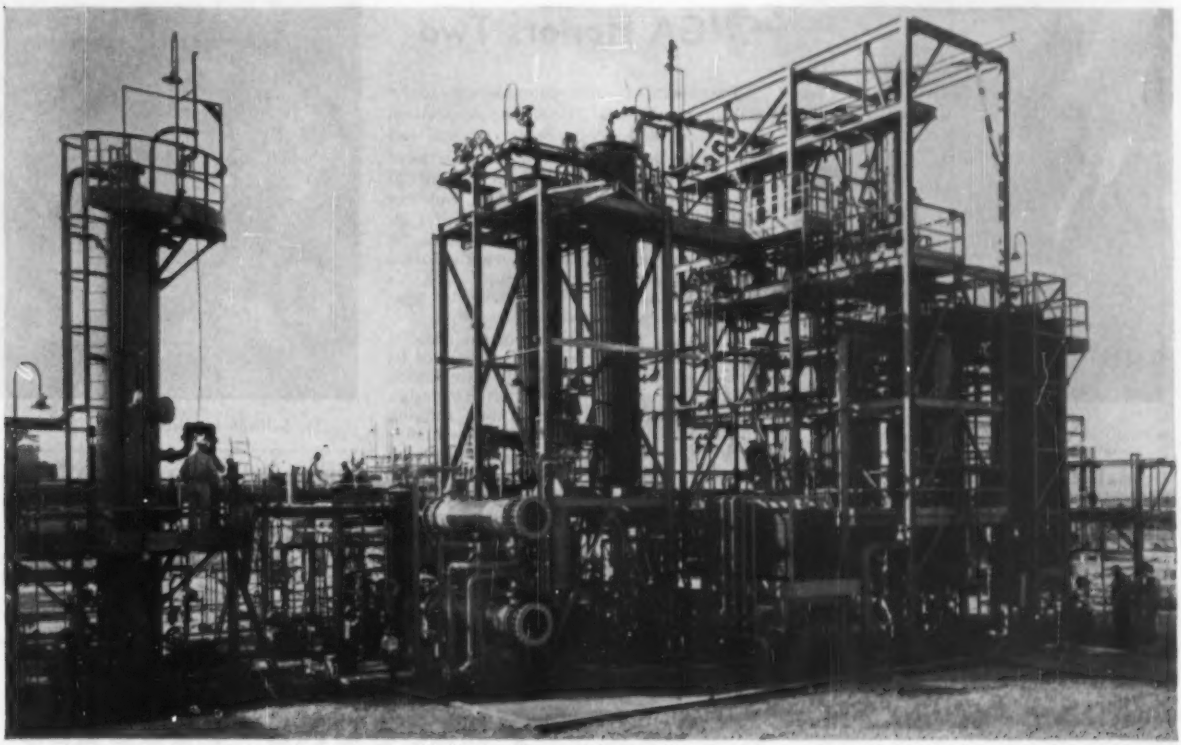

A recent petroleum chemicals plant designed and built primarily around the use of Haveg—a basic construction material that resists corrosion.

Petro-Chemical Corrosion has been Controlled!

Now for designers and engineers of petro-chemical plants there is an old and proven basic material of construction, borrowed from its 22 years of service in the chemical and metallurgical industries. It is Haveg, a plastic molded in the form of finished process equipment, or available for many types of field fabrication. Made from acid-digested asbestos and special thermosetting resins, Haveg enables you to go into a high range of process temperatures with complete safety and a proven history of outstanding performance.

Haveg has three great virtues. It is completely resistant to most corrosion. It lasts for years. It is amazingly versatile.

Not a coating or lining, Haveg gives resistance to corrosion through its entire mass, never allowing corrosives an opening wedge from cracks. It resists thermal shock, seldom requires insulation.

From steel-jacketed pressure process tanks down to the last piece of pipe, many of the petro-chemical processes can be completely contained and kept free from corrosion. Unnecessary maintenance, controls, headaches are avoided. Should plans or processes change, Haveg equipment can be machined and altered by your men, on the job. Accidental mechanical damage is easily repaired, using Haveg cement. Full chemical resistance is maintained.

If your job is fighting corrosion, get a helping hand from Haveg. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin F-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical answer to your design problems in handling petro-chemicals; in fact, in all process equipment that must handle corrosives.

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CHICAGO 11, DElaware 7-6088 • HOUSTON 4, Jackson 2-6840
CLEVELAND 20, Washington 1-8700 • LOS ANGELES 14, Mutual 1105
WESTFIELD, N. J., Westfield 2-7383

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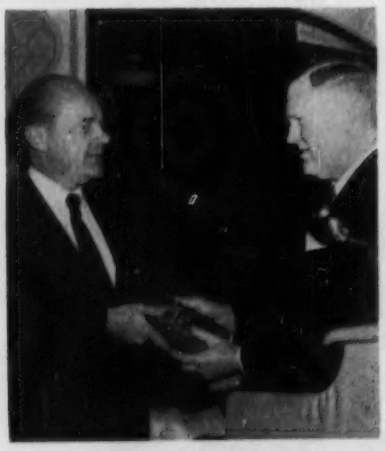
TRADE MARK REG. U. S. PAT. OFF.
A SUBSIDIARY OF HAVEG INDUSTRIES, INC.
930 GREENBANK ROAD • WILMINGTON 2, DEL. WYmen 8-2276

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry



Hartley Honored . . .

Daniel C. Hamilton has been appointed manager of the Economics department of The Atlantic Refining Company, and **E. T. Knight**, former acting manager, has been made associate economist. Dr. Hamilton formerly served Standard Oil Company (New Jersey) as industrial economist.

CNGA Honors Two

Two awards for meritorious service to the California Natural Gasoline Association were presented at its recent annual fall meeting in Los Angeles. The awards went to **Fred L. Hartley** (right), with Union Oil Company of California, and **A. J. Sullivan** (left), of Standard Oil Company of California. The presentations were made by **Grove Lawrence**, with Southern California Gas Company and chairman of CNGA's Awards Committee. This is the third year the association has made this award.

Hartley, a past president of the association and still a director and member of its executive committee, started with Union Oil in 1939. Long active in process design for natural-gasoline plants and refining units, he has served the company as manufacturing process supervisor, general superintendent at its Los Angeles refinery and manager of the Commercial Development division.

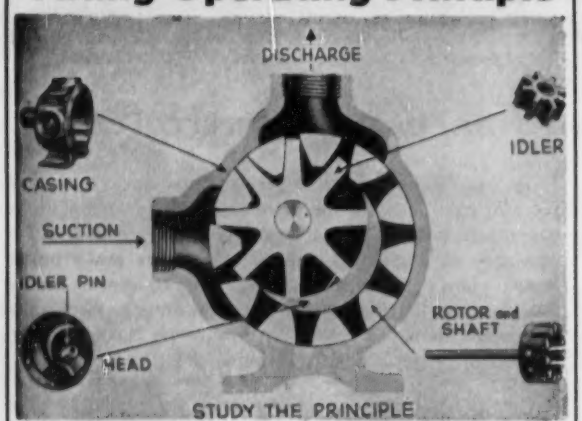
In addition to his activities with the CNGA, he is a member and former chairman of the AIChE's Southern California section.

Sullivan also is a CNGA director.

Sullivan Receives Award . . .

William M. Holaday, who has headed Socony Mobil Oil Company's research and development activities since 1944, has been appointed to a new position as coordinator of the company's planning for new products. He will be succeeded by **Dallas R. Lamont**, a patent counsel since 1931 and now a member of the Socony

Viking Operating Principle



Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

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PETRO-CHEMICAL PLANTS

You can use the wide experience of St. Mary Iron Works when you build pressure vessels. Our thoroughly experienced staff of designers, engineers and fabricators will furnish the equipment you need. Consult us before you start new construction.

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NITROGEN DIVISION
chemicals

Maximize the purity of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities – chlorides and acids – these products are consistently above standard purity specifications.

Call or write today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

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Diethylene Glycol

Triethylene Glycol

high purity
NITROGEN DIVISION
chemicals

Maximize the purity of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities – chlorides and acids – these products are consistently above standard purity specifications.

Call or write today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

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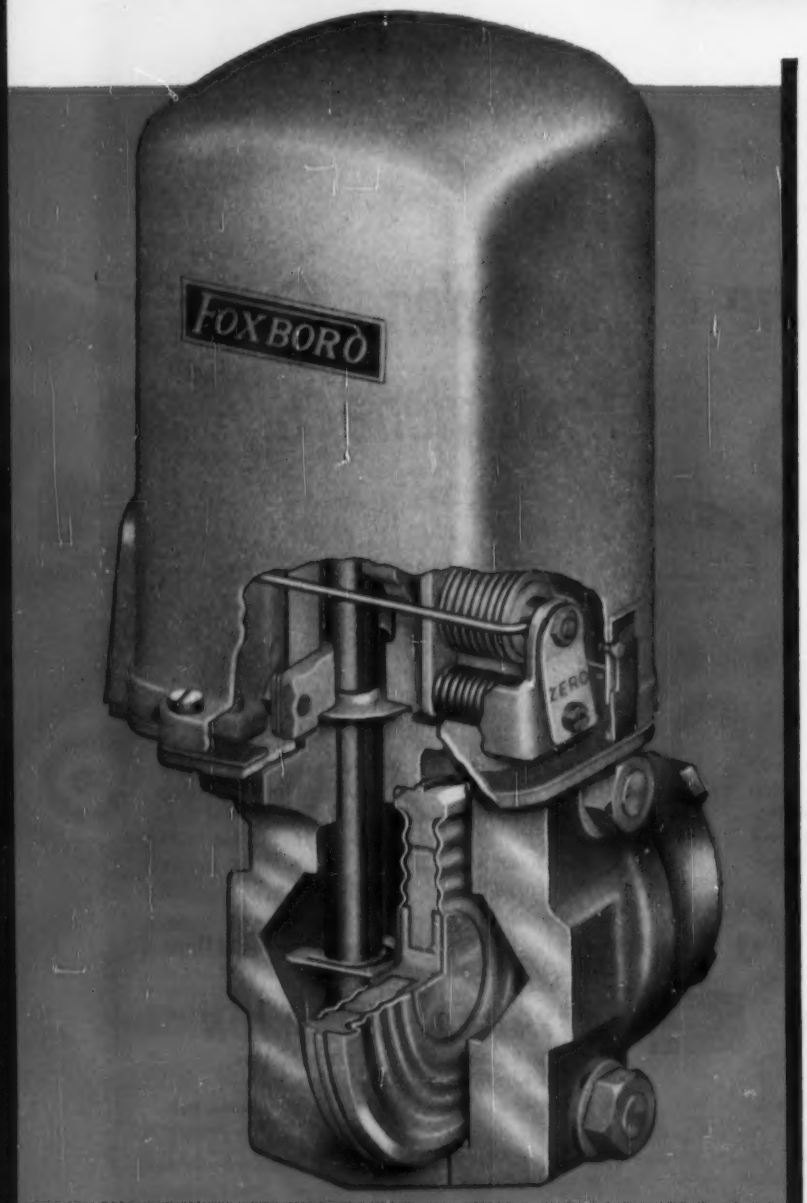
Ethanolamines • Ethylene Oxide • Ethylene Glycols • Formaldehyde • Nitrogen Tetroxide
Nitrogen Solutions • U.F. Concentrate—85 • Fertilizers & Feed Supplements

For more data on advertised products, use Readers' Service Cards, last page.

ONLY the Type 13A d/p has these 6 advanced-



- **Positive Overrange Protection** up to full 1500 lb. rating
- **Fully Adjustable Ranges . . .** 0-20" to 0-80" and 0-50" to 0-250" H_2O differential
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- **Simplicity** . . . easiest, lowest cost installation, least maintenance
- **Convenient Zero Adjustment** . . . external — no need to remove weatherproof cover
- **Highest Sustained Accuracy** . . . even under extreme operating and ambient conditions

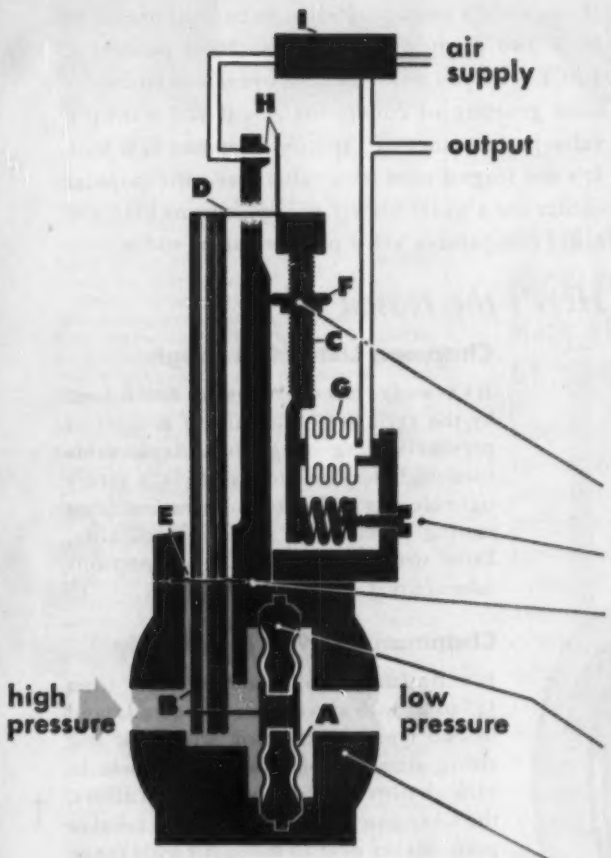
With these basic features, plus many other technical refinements throughout, the new Type 13A d/p Cell* Transmitter surpasses all previous records in performance . . . economy . . . convenience. For the complete story and a demonstration, call your nearest Foxboro representative. Write for new Bulletin 13-11. **The Foxboro Company, 3412 Neponset Ave., Foxboro, Mass., U.S.A.** Factories in the United States, Canada and England.

*Reg. U. S. Pat. Off.

More Foxboro flow transmitters are in use by the process industries than all other makes combined!

Cell Flow Transmitter

design features...



How It Works . . .

An increase in differential pressure across Twin-Diaphragm Capsule (A) exerts force to right on force bar (B). Elgiloy® diaphragm seal (E) acts as fulcrum. Force to left at top of bar (B) causes flapper to approach nozzle at (H). Resulting increase in nozzle pressure is amplified by relay (I). This pressure is sent to feedback bellows (G) which develops force to counterbalance the differential pressure on capsule (A). The 3-15 psi output signal from relay (I), always precisely proportional to differential pressure, is transmitted to remote recording or controlling instrument.

Range Wheel is continuously and easily adjustable for entire range whether 0-20" to 0-80" or 0-50" to 0-250" H_2O.

Easy-access screw adjustment permits field "zeroing" without removing weatherproof cover.

Elgiloy® stainless alloy diaphragm seal assures a corrosion-resistant, frictionless, positive pivot point. Instrument is constructed in 3 basic units — body, transmitter, and air relay block — eliminating all possibility of errors produced by piping stresses.

Silicone-filled Twin-Diaphragm Capsule filters out flow disturbances ("noise") at measurement source . . . without loss of speed of response. Precisely matched surfaces of diaphragms and capsule core provide "stops" which give positive overrange protection in both directions.

Rugged forged body, optionally Type 316 S.S. or carbon steel, gives greatest strength with least weight . . . ultra-compact design permits low cost mounting from flange taps.

FOXBORO
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First in Flow Instrumentation

One Answer

...for EVERY Small Forged Steel Gate Valve Application

Chapman List 960

If you want a small gate valve to control pressures from 380 pounds at 1000°F to 2000 pounds at 100°F . . . if you want low cost operation under the most grueling of conditions . . . if you want top valve performance . . . specify Chapman List 960. It's the forged steel gate valve that's the popular choice for a wider variety of applications than any other comparable valve on the market today.

Here's the reason why:

Chapman List 960 is tough

It has wedge faces hardened to 800 Brinell by the exclusive Malcomizing process to prevent seizing or galling. Replaceable hardened stainless steel seat rings assure tight closing and smooth operation. Snug seating permits full pressure repacking. Extra strong stem and gate connections take unusual stresses.

Chapman List 960 is versatile

It's available in all standard sizes from ¼" to 2" with screw or welding ends, and in two types, rising stem with yolk and rising stem with inside screw. Made in various alloys and combinations of alloys, the Chapman List 960 guarantees reliable performance over an unusually wide range of applications.

Whatever your needs for small forged steel gate valves the Chapman List 960 can do the job better and at lower operating cost. For higher pressures specify Chapman List 990. Write today for Catalog 10 and get full details.

The CHAPMAN Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

Mobil board. Lamont also will have charge of the company's laboratories, and Holaday will serve as chairman of an interdepartmental committee set up to carry out product-planning functions.

Holaday joined Socony Mobil in 1937 as assistant general manager of the company's laboratories. He previously had been a research engineer with Standard Oil Company (Indiana). During World War II, he served as chief of the Aviation section and later assistant director of refining for the Petroleum Administration for War. He returned to Socony Mobil in 1944 as director of the company's laboratories.

Harris

Venema

David W. Harris, president of Universal Oil Products Company for the past ten years, has been elected chairman of the board and chief executive officer. Named to succeed him as president is **M. P. Venema,** executive vice president since 1952.

Before joining the company in 1945, Harris was president of Arkansas Natural Gas Corporation. Prior to that he served as president of Orange State Oil Company and vice president and director of Cities Service Defense Corporation.

Venema has been with Universal for more than 20 years and earlier this year was elected a director of the company. He joined UOP as a junior chemical engineer and successively became a member of the Patent department in Washington, manager of the department, vice president and executive vice president.

Lee A. DuBridge, president of California Institute of Technology, has been elected chairman of the board of trustees of the Air Pollution Foundation. He succeeds **Raymond B. Allen,** chancellor of the University of California at Los Angeles.

Named vice president of the foundation board was **Fred B. Ortman,** president and chairman of the board of Gladding, McBean and Company. Other new appointments to the board include Dr. Allen, named to head its research committee; **A. J. Gock,** reappointed chairman of the finance committee; **F. M. Banks,** renamed public information chairman, and **James E. Shelton,** who will continue as treasurer of the foundation.

James P. Shambaugh, since 1952 assistant manager of the Process Promotion division of Socony Mobil Oil Company's Manufacturing department, has been moved up to manager of the division. He succeeds **Arthur V. Danner,** who has become a director and vice president of Mobil Overseas Oil Company.

Shambaugh joined the company in 1939 as a chemical engineer in the Research and Development laboratories at Paulsboro,

Here's How to Handle Corrosives at High Peripheral Speeds

CHEMLON YARN PACKING STYLE C-30 Made of TEFLON* FIBER BY "JOHN CRANE"

Chemlon Yarn Style C-30 extra tough packing gives you two important advantages not provided by other types of braided or molded Teflon packing: 1) positive sealing efficiency at high peripheral speeds; 2) cooler running stuffing box under severe service conditions.

Style C-30 can be used to handle the most destructive acids, alkalis or solvents. The excellent thermal properties of Teflon, combined with the softness, resiliency and fluid retentive properties of fine fiber construction, adapt it to high temperature conditions to +300°F. The packing is made firm and dense by means of a special process which eliminates *large* voids.

HERE'S PERFORMANCE PROOF:—Fluid handled: 45% H_2SO_4 (impure) at 170°F.—Operating conditions: 1¼" pump shaft at 1700 rpm. or 555 fpm. peripheral speed. Results: 46 days good service. Previous best service record 7 to 10 days.

Chemlon Yarn Packing Style C-30 is available in spool or coil form, in a wide range of sizes from ⅛" up. *Can be lubricated with Teflon suspensoid or various types of lubricants.*

Send for Bulletin No. P-321. Crane Packing Co., 1820 Cuyler Avenue, Chicago 13, Illinois. In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

*DuPont Trademark

JOHN CRANE CRANE PACKING COMPANY 28 YEARS INDUSTRIAL PROGRESS

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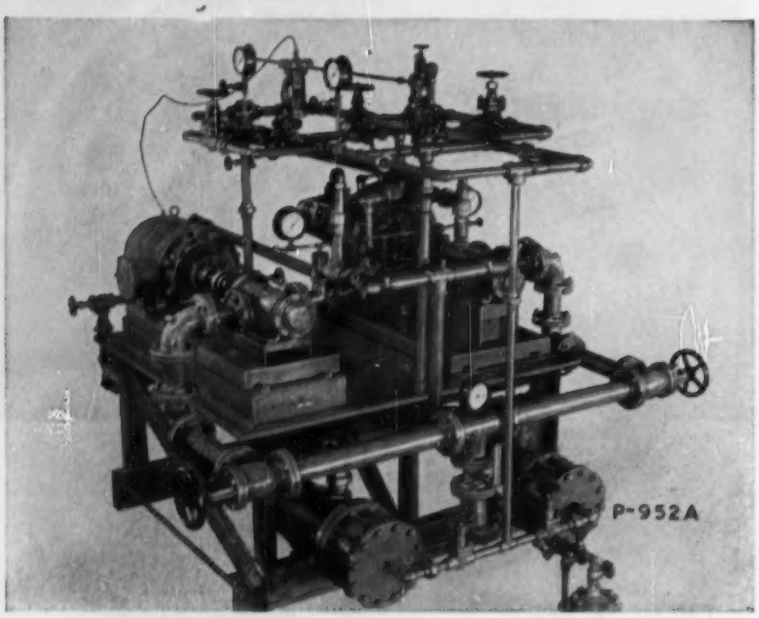
COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER..



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING *AND* HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40 — very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
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NATIONAL AIROIL BURNER CO., INC.

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What's Happening...

N. J., where he helped develop Socony Mobil's thermofor catalytic cracking process.

David P. Thornton, Jr., Southwestern editor of *Petroleum Processing* magazine, has joined the staff of Universal Oil Products Company as technical assistant to the director of public information. His work with UOP will involve the preparation of articles dealing with the installation and operation of its processing facilities.

Thornton

Thornton has been with publications serving the petroleum-refining industry for the past 15 years. He joined *Platt' Oilgram* in 1940 as market reporter, and two years later was made manager of the Tulsa office. From 1942 to 1946 he was assistant editor of the Technical section of *National Petroleum News*, and when the name of this section was changed to *Petroleum Processing* he became Southwestern editor.

William E. Ranz, associate professor in engineering research, at Pennslyvania State University, has been named recipient of the 1955 Junior Award in chemical engineering, granted by AIChE.

John E. Powers, formerly with Shell Development Company at Emeryville, Calif., has joined the faculty at the University of Oklahoma as an assistant professor of chemical engineering. Another new member of the chemical engineering staff is O. K. Crosser, recent doctor of philosophy from Rice Institute.

Powers, a chemical engineering graduate from the University of Michigan, completed his doctorate at the University of California at Berkeley in 1954. Crosser, one time connected with The B. F. Goodrich Company in its Research Center at Brecksville, Ohio, took his B.S. and M.S. degree at the University of Missouri.

T. L. Lenzen and **G. L. Parkhurst,** both vice presidents, have been named to fill vacancies on the board of directors of Standard Oil Company of California. And **J. P. Brown,** with the company since 1936, was elected assistant secretary.

Lenzen, prior to his appointment as a vice president in 1952, had been manager of the company's Eastern Hemisphere operations. With the company since 1928, he is a director of the affiliated Bahrain-Caltex Group.

Parkhurst, a vice president since 1949, previously was president of the subsidiary Oronite Chemical Company. He joined Oronite in 1946. Parkhurst is a director of Arabian American Oil Company and Trans-Arabia Pipe Line Company.

Daniel C. Hamilton has been appointed manager of the Economics department of The Atlantic Refining Company. **E. T. Knight,** former acting manager, was made associate economist.

W. M. Murray, with Deep Rock Oil Company in Oklahoma City, has been elected president of the National Lubri-

For more data on advertised products, use Readers' Service Cards, last page.

PETROLEUM CHEMICALS DIVISION
NEWS

December ★ One of a Series of Interest to the Petroleum Industry ★ 1955

Assistant Director of Sales

W. SAMUEL CARPENTER, III, was recently named assistant director of sales for the Du Pont Petroleum Chemicals Division.

Just prior to this assignment, Mr. Carpenter was director of manufacturing for the Cellulosics Division of the Textile Fibers Department. He joined the Du Pont Company in 1938 as an industrial engineer in the Engineering Department. In 1944, he was assigned to construction operations at Hanford, Washington, where the government's atomic energy project was built and operated by Du Pont during World War II.

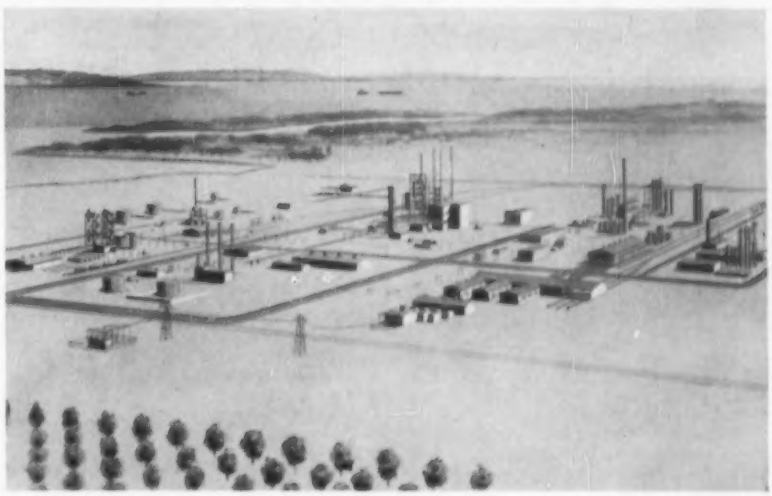
When he returned to Wilmington in 1945, he was assigned to the Construction Division of the Engineering Department. The following year he became manager of that department's Planning Division and later manager of its Industrial Engineering Division.

In 1947, Mr. Carpenter was transferred to the Rayon Division as assistant to the director of production. And in 1949, he became assistant manager of "Cordura" high-tenacity rayon yarn sales. Then he was named assistant manager of the Rayon Department Planning Division in 1950.

Mr. Carpenter is a graduate of Princeton University in chemical engineering.

Construction under way on new Du Pont California tetraethyl lead plant

Approximately 200 local California construction workers are now busy erecting a new Du Pont tetraethyl lead manufacturing plant on a site near Antioch, California. Also completely integrated on the same site will be facilities for manufacturing Du Pont "Freon" refrigerants, sodium, ethyl chloride, trichlorethylene and perchlorethylene.



Architect's sketch of Du Pont's new integrated plant under construction at Antioch, California.

The official ground-breaking took place on August 24. Immediately following, the engineering and construction crews moved on to the site—which is in the Diablo Valley, approximately two miles east of Antioch on the San Joaquin River. Since then the work has been progressing at a rapid pace and the new TEL plant is expected to go on stream in 1956.

The fast-growing TEL requirements of the West Coast petroleum industry prompted the Du Pont Company's decision to build the plant in California. The convenient location of the Antioch site makes it readily accessible to both water and rail transportation.

Latest improvements

The new West Coast plant will house the most modern tetraethyl lead manufacturing facilities in the world. It will not only employ the new continuous process developed by Du Pont at the company's Chambers Works plant in

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *California Plant*

New Jersey, but will also include many new refinements which make this modern process more efficient than ever.

Why the drilling rig?

Did you ever hear of anyone making a 7,000-foot hole in the ground with an oil drilling rig – yet hoping they *wouldn't* strike oil? That's what the Du Pont Company did on the Antioch site.

The hole will provide a means for disposing of brine wastes without any possibility of contamination of surface water or subterranean water resources. The well was "brought in" by the Brown Drilling Company in August, the first part of the new project to be completed.

Integrated production

Although the original Du Pont plan called for only the TEL and "Freon" manufacturing facilities at Antioch, the additional facilities for making other chemicals will add greatly to the efficiency of the over-all unit. This is because sodium and ethyl chloride are essential ingredients in the manufacture of tetraethyl lead.

Besides supplying intermediates for

Continued—middle of next column

TEL, the plant will also produce metallic sodium for Du Pont customers on the West Coast. It is widely used in metal descaling, especially for stainless steel. The trichlorethylene will go chiefly to West Coast aircraft and metal fabricating industries for degreasing metal parts. The dry cleaning industry is the chief consumer of perchlorethylene.

Due to the rapid expansion of West Coast industry, there is a definite need for the new California plant. And its establishment will enable Du Pont to give its West Coast customers the utmost in delivery service.

The three primary raw materials needed by the plant – lead, propane and salt – will be purchased locally. Propane, made from petroleum, will be brought into the plant from nearby refineries.

Creating new jobs

When completed, the over-all Du Pont facilities at Antioch will provide production jobs for some 500 people. The majority of these will be hired locally. At the peak of construction, about 500 workers will also be employed for building the plant.

ANOTHER DU PONT MARKETING SERVICE

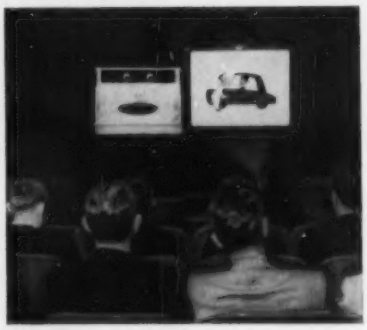
New "SELL YOURSELF" dealer training program offered

No matter how excellent the products he sells, a service station operator's success depends to a large degree on how well he sells *himself*.

But this involves *intangible* factors such as personality, friendliness, helpfulness. How, you may ask, can you impart such abilities to hundreds of individual and independent dealers? Actually the problem may not be as difficult as it looks on the surface.

To help you dramatize these factors and show your dealers how they pay off at the cash register, the Du Pont Petroleum Chemicals Division has prepared a unique 30-minute presentation. An animated, *talking* cash register acts as master of ceremonies. This is manually synchronized with a full-color animated cartoon movie.

It shows, in a very simple, easy-to-understand way, how any service station attendant can capitalize on everyday human relations. And it clearly demonstrates the selling power of personal neatness, friendly conversation and common courtesy.



The principal characters in the movie story are on-the-ball Joe Wright, a successful service station operator, and sloppy Joe Wrong, whose poor appearance and disagreeable attitude drive business away from his station. The simplicity of the story makes it unusually penetrating and convincing.

How soon would you like to make use of a "Sell Yourself" presentation in your own dealer training program? Any of our sales offices listed below will be glad to schedule it for you.

DU PONT
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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

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Printed in U. S. A.

What's Happening. . .

cating Grease Institute. Serving with him will be **J. W. Lane**, Socony Mobil Oil Company, named vice president. Other officers are **A. J. Daniel**, Battenfield Oil & Gas Corporation, made treasurer, and **Harry F. Bennetts**, who continues as executive secretary.

E. J. Kirberg, former manager of the process division of Gulf Oil Corporation's Manufacturing department, has been named coordinator. He will be responsible for coordinating the long-range plans for the department with those of other departments of the company.

Kirberg

Other new appointments in the Manufacturing department include the assignment of **B. R. Dorsey**, who was manager of an affiliated refinery in Venezuela, to a position as administrative assistant to the vice president.

R. S. Justiss, who has been managing the previously-designated Construction and Maintenance division, becomes chief engineer for a newly-created Engineering division.

P. K. Kuhne, former assistant manager of Gulf's Technical division, has been made director of the Products division, which is taking over the functions of the Technical division.

Paul Siecke, former assistant manager of the Process division, becomes chief process engineer responsible for directing the work of the Process division.

John F. Campbell has been appointed field director for the API's Oil Industry Information Committee. Formerly Midwest regional director for the industry-wide public relations program, he also has served as district representative in the Boston and Chicago offices.

J. W. Lenon, senior district representative in the Kentucky-Ohio-Tennessee district office at Cincinnati, was named Campbell's successor in Chicago, as Midwest regional director. **John Richardson**, of the Cincinnati office, was promoted to the Lenon vacancy.

E. S. Pettyjohn, since 1945 director of the Institute of Gas Technology, affiliated with Illinois Institute of Technology, has resigned. **Dr. Henry R. Linden**, research director, will serve as acting director until a successor to Pettyjohn is selected.

L. T. Wilson, has been made manager of the Shell Oil Company of Canada, Ltd., refinery at Montreal East. He formerly was superintendent of the Shell refinery at Norco, La. He started with the Shell organization in 1933 as a junior inspector at the Wilmington, Calif., refinery. Since then he has served in a number of Shell refineries, holding positions as senior technologist, assistant manager of the Catalytic Cracking department, assistant superintendent and superintendent.

Nicholas J. Campbell, Jr., has been elected vice president of Creole Petroleum Corporation. Now manager of the com-

Amazing Time Savers

FOR PIPEFITTERS • ELECTRICIANS
PLUMBERS • MAINTENANCE MEN

New Millers Falls Deep-Cut Hole Saws

cut through

METAL
PIPE
WOOD
PLASTER

any machinable material

Save time. Save work. These rugged new hole saws will speed up countless jobs for you. With a special *high speed steel* cutting edge welded to a tough chrome-vanadium body, they bite through practically any material.

You can use them to cut into metal pipes and tanks — or for boring holes fast in walls, floors and partitions. They go through wire nails, screws, metal lath and most other metal obstructions without damage to their sharp cutting teeth.

Depth of cut is a full 2½". And, since these saws can follow through the holes they make, you can cut to almost any depth by removing the core as you go along. Good chip clearance, so necessary for rapid cutting, is assured by the spiral elevator groove in the body of the saw.

Get a set of these remarkable new Millers Falls Deep Cut Hole Saws. They come complete in the compact steel carrying case shown above — 6 saws from 1 1/16" to 2 9/16" diameter, plus 2 mandrels with 3/8" pilot drills. Buy yours today. They'll pay you back fast in the time and work they save.

SEE THEM AT YOUR SUPPLIER TODAY

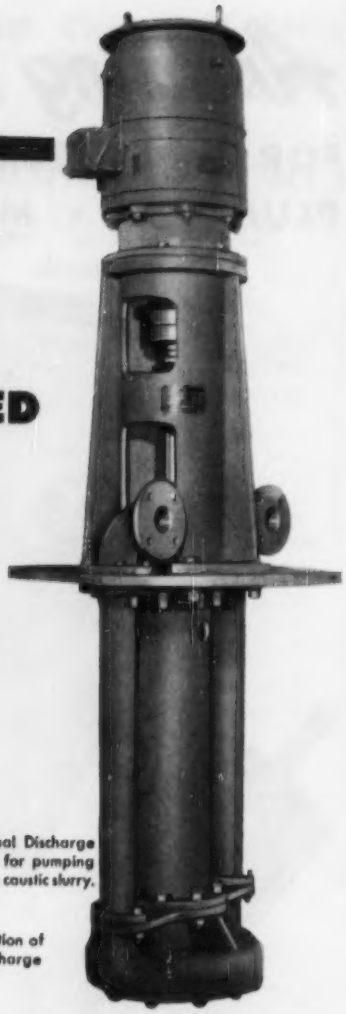
Write for catalog of Millers Falls Tools

MILLERS FALLS COMPANY
Dept. PF-2, Greenfield, Mass.

MILLERS FALLS TOOLS
SINCE 1868

For more data on advertised products, use Readers' Service Cards, last page.

VERTICAL PUMPS WITH NO SUBMERGED BEARINGS FOR PUMPING ABRASIVE CORROSIVE SLURRIES



2" Dual Discharge Pump for pumping molten caustic slurry.

Cross section of Dual Discharge Pump.

This rugged type of service calls for advanced design — extra heavy shaft, double-ported casing to equalize the side thrust of the impeller, and tough abrasion-corrosion resistant alloys. The dual discharge pump illustrated here incorporates these features and dispenses with bearings or packing below the cover plate where they would be in contact with the liquid.

Difficult pumping problems, particularly in the process industries, have been our specialty for ninety-one years. Perhaps we can be of help to you. Write us — no obligation.

LAWRENCE PUMPS INC.

Write for Bulletin 203-6 for complete summary of acid and chemical pump data.

371 MARKET STREET, LAWRENCE, MASS.

What's Happening. . .

pany's Law department in Caracas, Venezuela, he will be transferred to the New York office.

Campbell started with Creole in 1947 as an attorney in its New York office, and in 1950 was transferred to the Caracas office where he was appointed assistant manager of the Law department. He was made manager in October 1953.

Edgar C. Britton, director of the Edgar C. Britton Research Laboratory of The Dow Chemical Company in Midland, Mich., and past president of the A.C.S., has been chosen to receive the Perkin Medal of the American Section, Society of Chemical Industry, for 1956.

Joseph G. Davidson, vice president of Union Carbide and Carbon Corporation, has been awarded the Chemical Industry Medal for 1955, conferred upon him for "conspicuous service to applied chemistry." Presentation of the award took place at a meeting of the American Section of the Society of Chemical Industry in New York.

Joseph W. Calby has joined Acheson Industries, Inc., as assistant to the technical director. He was assigned to the company's Newark, N. J., offices. Calby previously was stationed at the Army Chemical Center as a group leader of piloting processes for making toxic agents, and one time served The Atlantic Refining Company as an assistant chemical engineer in the Economic Evaluation division.

Calby

Robert E. Wilson, chairman of the board for Standard Oil Company (Indiana), has accepted the chairmanship of the Petroleum and Natural Gas division of the Committee of American Industry. The committee is a division of the National Fund for Medical Education. A number of men prominent in petroleum affairs will serve with Dr. Wilson.

Arthur M. Sherwood, legal counsel for Socony Mobil Oil Company, has been moved up to assistant secretary. Sherwood joined the company in 1954 as legal counsel. He previously had been associated with a New York law firm.

Sam E. Powers, Sr., has been promoted to foreman of the Railroad and Shipping department at Humble Oil & Refining Company's Baytown, Texas, refinery. With Missouri Pacific Railway Company before he joined Humble in 1942, he has been clerk, yard supervisor, and one time served on a training assignment as foreman of the Railroad department at the refinery.

Phillip S. Magruder, executive vice president and a director of General Petroleum Corporation has completed 30 years with that company. A vice president since 1946, he was appointed a director of the corporation and manager of its Manufacturing department in 1945. He joined

For more data on advertised products, use Readers' Service Cards, last page.

ROCKWOOD ALL-PURPOSE FOAM can be used to blanket fires in alcohols, ethers, esters, ketones, as well as petroleum products.

Now... one FOAM extinguishes both petroleum and alcohol fires

New Rockwood All-Purpose FOAM does the work of two products. Simplifies training of fire fighting personnel and cuts down fire protection inventory. Rockwood All-Purpose FOAM quickly puts out fires in alcohols, ketones, ethers and similar water soluble materials as well as petroleum derivatives.

Rockwood All-Purpose FOAM reduces fire protection equipment for fire departments and plants which must deal with more than one type of fire hazard, and is ideally suited for Rockwood's SpotPROTECTION or fixed piping systems.

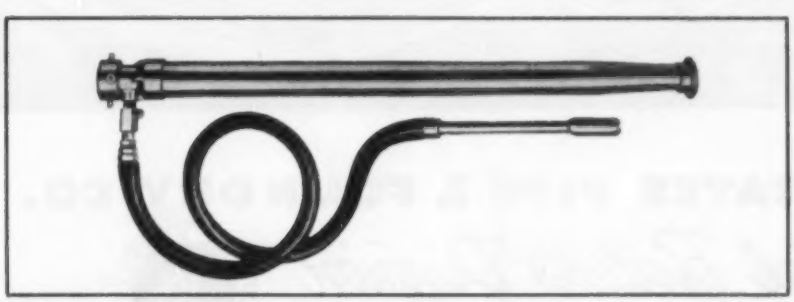
Rockwood All-Purpose FOAM is well suited for use by municipal fire departments, oil refineries, distilleries, chemical and other industrial plants.

Rockwood All-Purpose FOAM liquid with standard Rockwood FOAM nozzle provides the simplest, fastest means for extinguishing alcohol, solvent fires. The FOAM nozzle attaches to a hose connected to the discharge gate of a fire truck, hydrant or interior hose station.

Specify new Rockwood All-Purpose FOAM, put this versatile fire fighter to work for you.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses



1½" STANDARD FOAM NOZZLE AND PICK-UP TUBE discharges 60 g.p.m. at 100 p.s.i. Range: approximately 55 feet.

SEND FOR THIS INFORMATIVE BOOKLET

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
1087 Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Rockwood fire fighting products.

Name.....

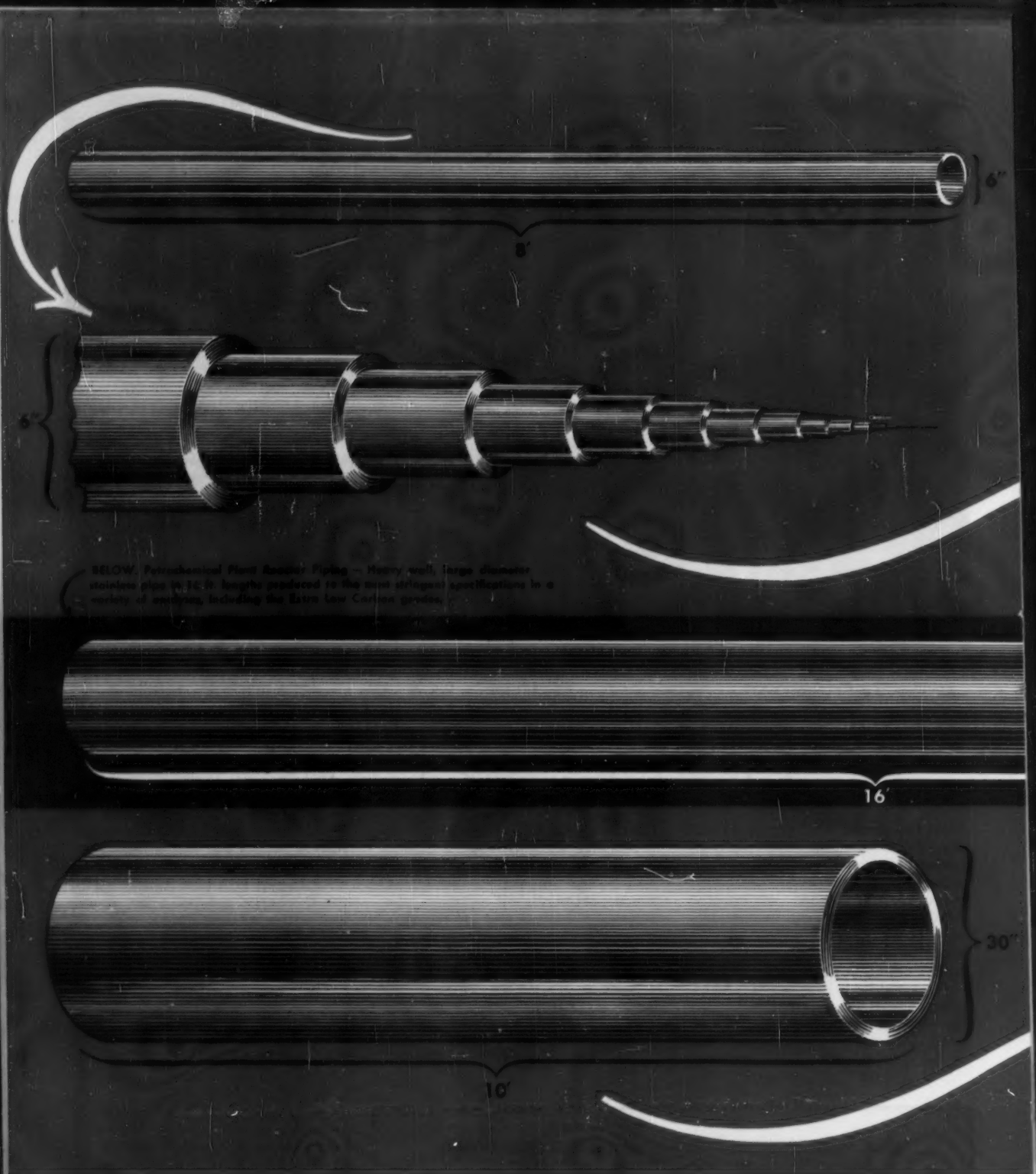
Title.....

Company.....

Street.....

City.....Zone..State.....

For more data on advertised products, use Readers' Service Cards, last page.



BELOW: Petrochemical Plant Reactor Piping — Heavy wall, large diameter stainless pipe up to 16' in lengths produced to the most stringent specifications in a variety of analyses, including the Extra Low Carbon grades.

UNITED STATES PIPE & FOUNDRY CO.

Special Products Division

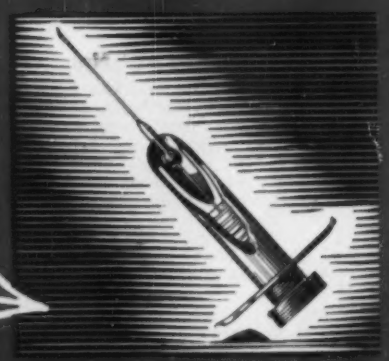
SPECIAL PRODUCTS DIVISION USP

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, CLEVELAND, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

3 PROBLEMS
each different

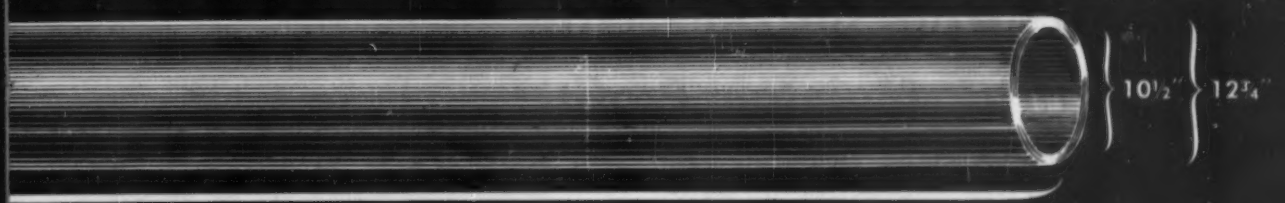
1 SOLUTION...
stainless steel
Centrifugal Castings

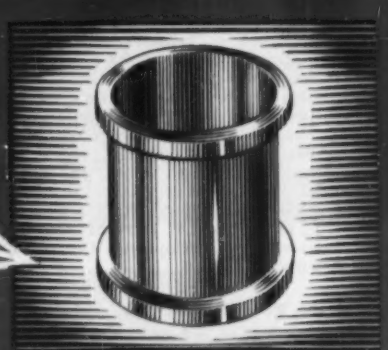


Hollow billets for cold reducing into small diameter seamless tubing, even down to hypodermic needles—ultimate proof of metal soundness! Many so-called non-piercable grades of pipe and tubing can be hot or cold reduced from centrifugally cast billets.

Heavy Wall stainless steel pipe, centrifuge bowls, hollow billets for finely drawn hypodermic needle tubing . . .

These are among the many end uses for metal mold centrifugally cast cylindrical shapes. They are typical of the exacting, difficult service conditions to which this product is subjected. All three examples shown demonstrate the fundamental versatility of this manufacturing process—unequaled product soundness—from hypodermic needle stock subjected to the repeated stresses of cold reduction, to the centrifuge bowl spun





Centrifuge Bowl Shells produced from multiple length sections and machined to shape desired.

at 1800 RPM, to the petrochemical plant reactor piping that must pass hydrostatic pressure tests equal to 90% of the Yield Strength of the metal. These are the proving grounds of quality—of the ability to meet even the most exacting of product specifications.

We welcome your inquiries. For descriptive literature on the versatile metal mold process, write to United States Pipe and Foundry Company, Special Products Division, Burlington, N. J.

Study these advantages for your cylindrically-shaped products

- **Reduced processing time and increased production.**
- **Design of parts to suit the specific job requirements by selecting the correct alloy—not the next best available alternate.**
- **Conservation of expensive metals and alloys—especially on tubular parts now produced from solid sections.**

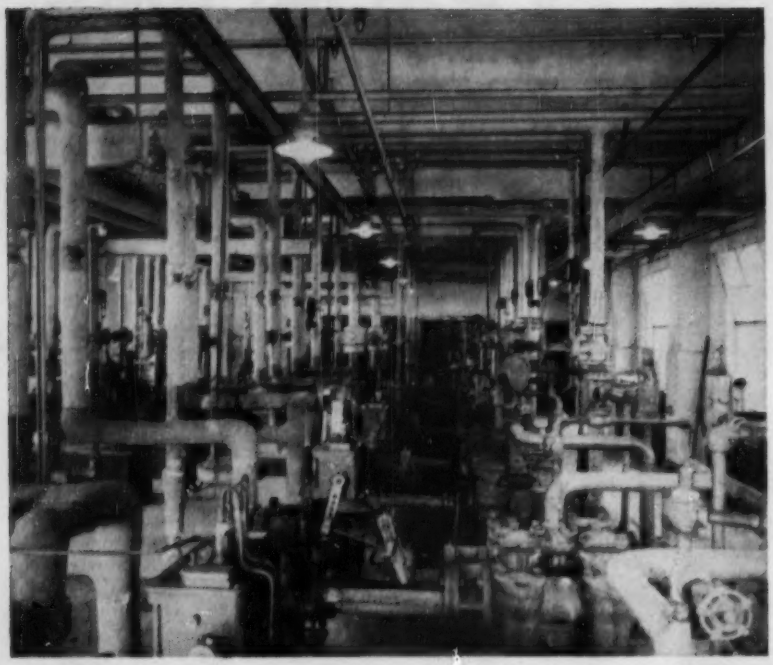
SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—4" to 36"

Wall Thickness—⅜" and up

Length—Up to 16' in the "as-cast" condition

Types of Stainless Cast—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.



ENGINEERED PROTECTION

To Lick Fire—Maintain Profits!

Close inspection reveals much more than meets the eye in this petroleum refinery pump room. "Automatic" FIRE-FOG protection, ENGINEERED to this specific risk, is ready at all times to detect and extinguish fire, should it threaten to destroy property, halt production, reduce profits.

This is but one type of a wide variety of fire-fighting systems designed, manufactured and installed by "Automatic" Sprinkler Corp. of America. Others employing AIR FOAM, high or low pressure CO_2, Dry Powder, etc. stand guard over scores of petroleum and petro-chemical properties throughout the world.

The time to plan ENGINEERED "Automatic" FIRE PROTECTION is **before** fire strikes—not **after** fire has destroyed. Contact your nearest "Automatic" Sprinkler fire protection engineer for an appointment with a Safety First future. He'll gladly prepare a fire protection analysis for you without cost or obligation.

"Automatic" Sprinkler
CORPORATION OF AMERICA
YOUNGSTOWN, OHIO

Offices in Principal Cities of North and South America

What's Happening. . .

General Petroleum in 1925 as a tester in the Gas department at the company's refinery then located at Vernon, Calif. He became manager of the Gas department in 1942, having served 13 years as general superintendent.

Nat C. Robertson has been appointed director of research for Escambia Bay Chemical Corporation, a concern with a multi-million petrochemical plant under construction near Pensacola, Fla. Dr. Robertson will make his headquarters temporarily with the National Research Corporation in Cambridge, Mass., where he has been director of the Petrochemical department for several years.

During World War II Dr. Robertson was with Standard Oil Development Company, conducting special research projects in synthetic rubber. From 1947 to 1951 he was in charge of a physical chemistry research group with Celanese Corporation of America.

George A. Lindquist has been made construction manager of H. K. Ferguson Company's ten-state Western district.

Alex G. Oblad, manager of research and development for Houdry Process Corporation, has been elected chairman of the American Chemical Society's Division of Petroleum Chemistry. He succeeds **Dr. Everett C. Hughes,** chief of the chemical and Physical Research division of The Standard Oil Company (Ohio).

Dr. Sherman S. Shaffer, staff associate in the Refining, Technical and Research divisions of Humble Oil & Refining Company's Baytown, Texas, refinery, was named chairman-elect. Also serving with Dr. Oblad is **Wheeler G. Lovell,** director of automotive products developing for Ethyl Corporation. He was re-elected secretary-treasurer.

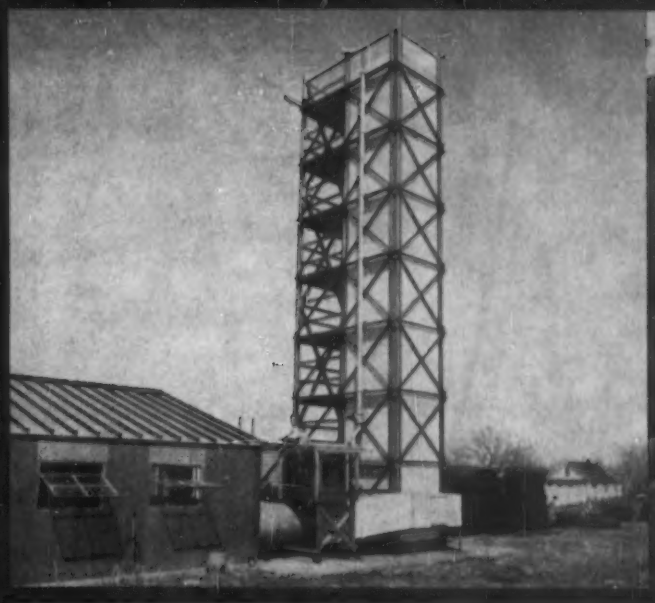
Chosen to represent the division's six geographic areas on the division executive committee: **John S. Ball,** Bureau of Mines, Laramie, Wyo.; **Dr. Philip C. White,** Pan American Refining Corporation, Texas City, Texas; **Dr. Robert E. Marschner,** Standard Oil Company (Indiana), Whiting; **Dr. Leslie C. Beard, Jr.,** Socony Mobil Oil Company, New York; **Dr. John W. Brooks,** Socony Mobil's Paulsboro, N. J., plant, and **Dr. Jerry McAfee,** Gulf Research & Development Company, Pittsburgh.

P. V. Keyser, Jr., has been named president of the new Mobil Overseas Oil Company, Inc., established to handle foreign operations for Socony Mobil Oil Company, Inc. (See **What's Happening.**) He will continue as a director and vice president of Socony Mobil. Named as vice president in charge of manufacturing is **R. R. Jackson,** who also will serve as a director. **W. L. King** was named director and general counsel, and **J. H. B. Wellacott** was made director in charge of finance. **A. L. Lanckton** was elected secretary; **E. J. Glocke,** comptroller, and **F. L. White,** treasurer.

Bernard F. Kallas, formerly with the South Dakota highway department, has been appointed to the research staff of the Asphalt Institute. He will serve as assistant in direct charge of laboratory activities. Until accepting his new position, Kallas

For more data on advertised products, use Readers' Service Cards, last page.

ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

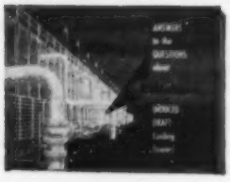


LABORATORY TESTS PROVE PRITCHARD FILLING SUPERIORITY...

At Pritchard's modern cooling tower research facilities, impartial comparative tests have been run on all known commercial deck filling now in use in counterflow cooling towers. Performance of decks were determined under identical conditions of water flow, air flow, inlet wet and dry bulbs and heat load, all precisely controlled to give extremely accurate performance data. Under these rigid conditions, Pritchard deck fill demonstrated its superiority over other commercial designs.

Performance is not the only factor in Pritchard filling design. It is conservatively sized to give years and years of service without deterioration. It is sturdy and permanently positioned. It is not subject to displacement from high winds or any other operating conditions. Yet it is easy to remove for access to the tower. Made of clear all heart redwood.

Pritchard filling, proved best by laboratory test, is one more reason to choose Pritchard Cooling Towers.



GET ALL THE FACTS BEFORE YOU CHOOSE!

"ANSWERS TO 15 QUESTIONS ABOUT PRITCHARD INDUCED DRAFT COOLING TOWERS" is a fascinating brochure. It gives you the answers to nearly every cooling tower problem; includes tips on how to choose cooling towers; other valuable data. This brochure takes you right inside a typical Pritchard tower to show you — feature by feature—why Pritchard is the new design leader. Write for this complimentary brochure on your company letterhead today, won't you?

INDUSTRY'S PARTNER FOR PROGRESS

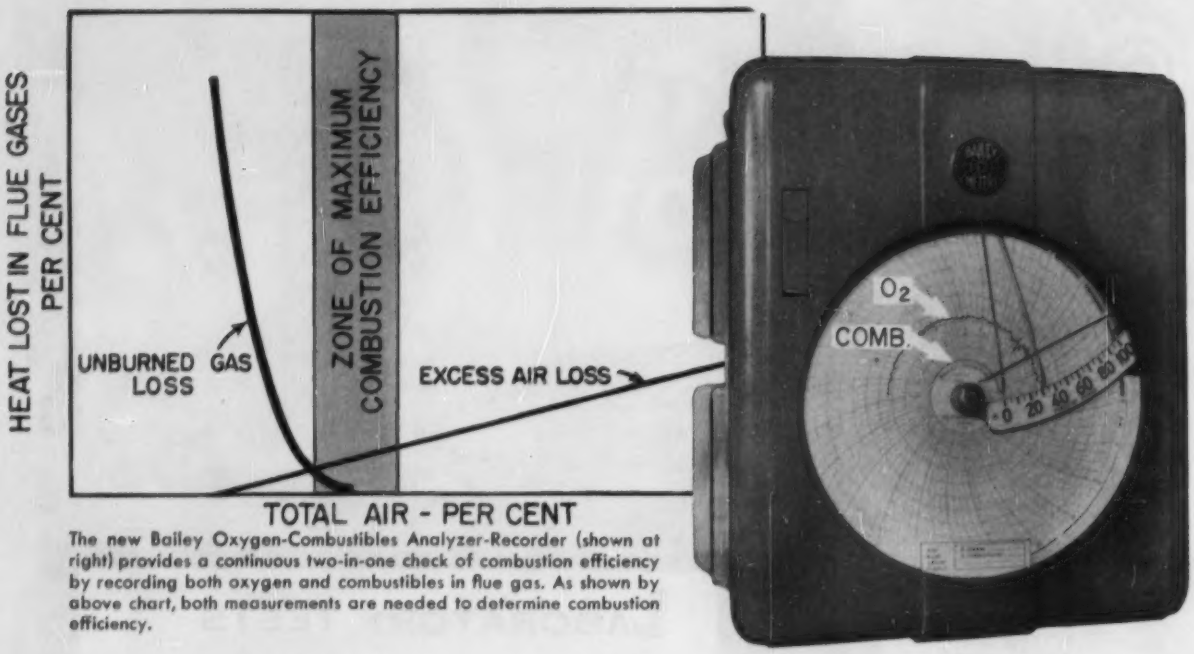
COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA

A DIVISION OF J. F. PRITCHARD & CO

Dept. 465, 4625 Roanoke Parkway, Kansas City 12, Mo.



The new Bailey Oxygen-Combustibles Analyzer-Recorder (shown at right) provides a continuous two-in-one check of combustion efficiency by recording both oxygen and combustibles in flue gas. As shown by above chart, both measurements are needed to determine combustion efficiency.

BAILEY announces . . . New 2 in 1 way to measure Combustion Efficiency

The new Bailey Oxygen-Combustibles Analyzer-Recorder gives you a continuing double check on combustion economy. It's fast response measures and records:

1. Excess air—regardless of the fuel or combinations of fuels being burned.

2. The mixing efficiency of your fuel-burning equipment—by indicating the amount of combustibles in your flue gas, resulting from incomplete mixing of fuel and air.

Combustion efficiency depends upon fuel-air ratio. Too much fuel can be even more costly than too much air. And because of the interdependence of these two factors, no control that measures only one of them can give you complete protection.

Now, for the first time, you can check *both* with a *single* fast acting instrument, using the new Bailey Oxygen-Combustibles Analyzer-Recorder for industrial furnaces, kilns, heaters and boilers.

Fuel economy improves as excess air is reduced —until unburned fuel begins to show up in the flue gas. When this happens, combustion efficiency drops off sharply if there are further decreases in the air-fuel ratio. That's why combustion gases must be analyzed for *both* oxygen and combustibles to get a true indication of efficiency—and that is why Bailey coordinates both measurements on the same chart, to show when excess air may be reduced safely without danger of greater losses from unburned gases.

The Bailey Oxygen-Combustibles Analyzer is an approved combustion safeguard.

Ask your local Bailey engineer for suggestions on application. Equipment details in Product Specifications E65-1 and E12-5. P31-1

BAILEY METER COMPANY

1043 IVANHOE ROAD • CLEVELAND 10, OHIO

INSTRUMENTS AND CONTROLS

For Power And Process

What's Happening. . .

served in the South Dakota soils laboratory, assigned to the design and control of bituminous mixtures.

John W. Crowther has been named product manager for chlorinated solvents of Frontier Chemical Company in Wichita, Kansas. The new chlorinated solvents line is in addition to the company's chemical production at its Wichita and Denver City, Texas, plants.

John A. Nevison has been appointed head of a new Licensing section of The Atlantic Refining Company's Research and Development department. He succeeds **Byron E. Milner** who was made technical assistant to the vice president and manager of the Manufacturing department.

Nevison has been assistant head of the Licensing section since its organization in 1952. He joined Atlantic in 1935.

Named to replace him as assistant manager is **James H. McCullough,** who has been in process development and plant experimental work for the Research and Development department. He has been with the company since 1926.

Paul H. Smith has been elected vice president of Refinery Engineering Company. Formerly chief estimator, he steps up to vice president in charge of construction. Other new appointments in the organization include:

D. F. Ferguson, named process development engineer; **A. C. Frederick,** chief process engineer; **D. B. Crawford,** chief estimator, and **W. L. White, D. R. Turner** and **L. D. Travis,** all made project engineers.

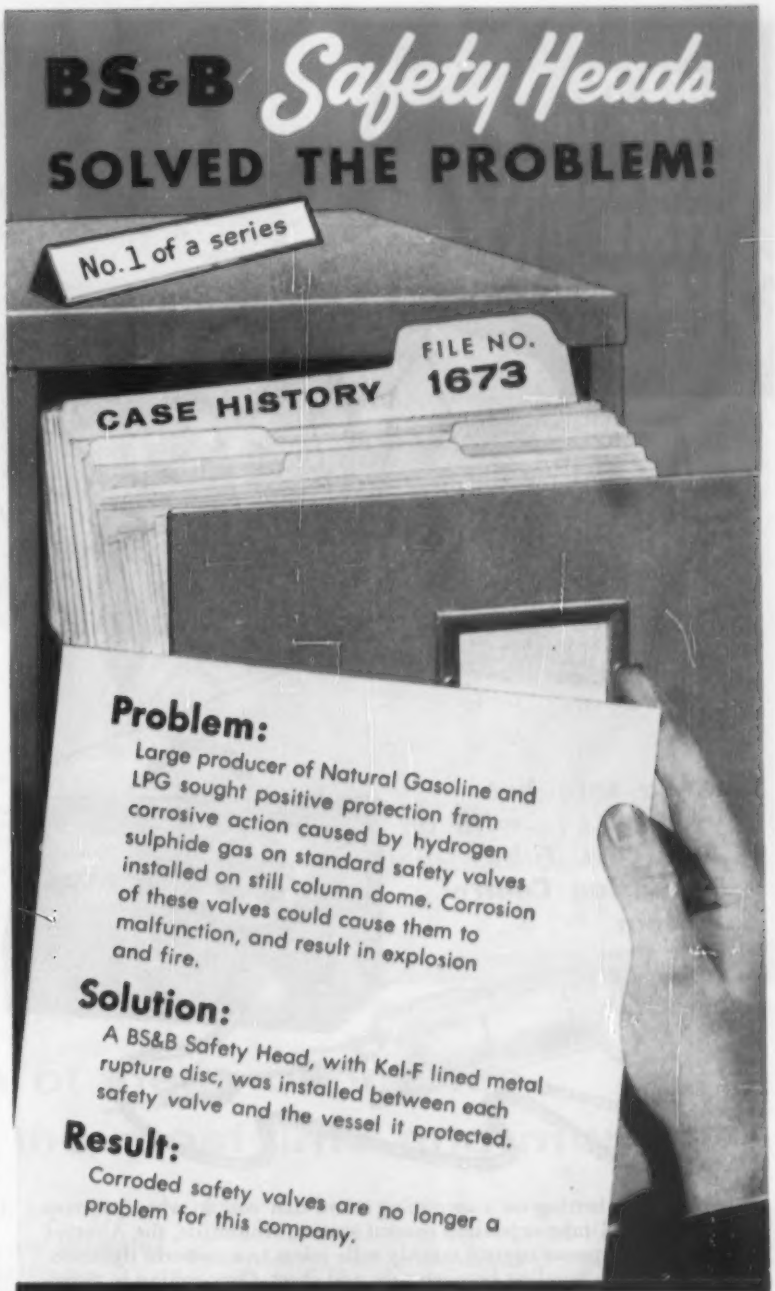
Asa V. Call, Los Angeles businessman, has been elected to the board of directors of Standard Oil Company of California. He has been president and director of Pacific Mutual Life Insurance Company since 1942.

A. D. Suttle has been promoted to senior research chemist in the Research and Development department at Humble Oil & Refining Company's Baytown, Texas, refinery. He will direct his research efforts to studies in radiation chemistry. Dr. Suttle received his Ph.D. in radiochemistry at the University of Chicago.

Warren E. Lovejoy has been named manager of the Safety division, Personnel department, Standard Oil Company of California. He succeeds the late **R. E. Donovan.** Lovejoy joined Standard in 1924 as an estimator and personnel representative and was named personnel supervisor of California Research Corporation in 1951. He was appointed assistant to the manager, Safety division, in 1953.

E. A. Malick has been promoted from assistant manager to manager of Phillips Petroleum Company's Rocket Fuels division in the Research and Development department at McGregor, Texas. **P. M. Arnold** has been acting as manager of the division, in addition to his duties as manager of the Research and Development department.

Other management changes in the Rocket Fuels division include **L. A. Macuila,** promoted to succeed Malick as assistant


BS&B Safety Heads
SOLVED THE PROBLEM!
No. 1 of a series
CASE HISTORY
FILE NO. 1673
Problem:
Large producer of Natural Gasoline and LPG sought positive protection from corrosive action caused by hydrogen sulphide gas on standard safety valves installed on still column dome. Corrosion of these valves could cause them to malfunction, and result in explosion and fire.
Solution:
A BS&B Safety Head, with Kel-F lined metal rupture disc, was installed between each safety valve and the vessel it protected.
Result:
Corroded safety valves are no longer a problem for this company.

BS&B — OVER 50 YEARS — RELIABILITY — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Have you considered what BS&B Safety Heads can do to improve the safety of **your** pressurized equipment? Complete information on the many possible applications of BS&B Safety Heads will be sent on request.

THE "CIRCUIT-BREAKER" of Pressured Systems

BLACK, SIVALLS & BRYSON, INC.
Safety Head Division, Dept. 2-F12
7500 East 12th Street Kansas City 26, Missouri

For more data on advertised products, use Readers' Service Cards, last page.

It's a safe bet you WILL...with an AIRETOOL Tube Expansion Control System

Nothing beats betting on a *sure* thing! And that you do when you rely on the Airetool tube expansion control system. Automatic, the Airetool system with its preset control quickly rolls joints to a uniform tightness. Gives maximum bonding between tube and sheet. Over-rolling is, therefore, eliminated . . . and rolling time is notably shortened, from hours to minutes.

Motors are available in four sizes to supply proper power for your purpose. Entire system is portable.

Call for an ON-YOUR-JOB DEMONSTRATION Today!

BRANCH OFFICES:
New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

REPRESENTATIVES
in principal cities of U.S.A., Canada, Mexico, England, South America, Puerto Rico, Japan, Italy, Hawaii.
European Plant: Airetool Nederland N.V., Vlaardingen, The Netherlands.

"There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction."

What's Happening. . .

manager, and **A. E. Inman** named manager of management services; **J. F. Sauls** as manager of employe relations, and **J. E. Dillingham,** manager of contracts and finance. **F. M. Files** continues as manager of manufacturing, with **R. J. Martinelli** appointed as assistant manager.

A new Technical Development branch was organized, with **E. F. Fiock** as technical director and **J. A. McBride** as assistant technical director.

Cecil Morgan, government relations counselor for Standard Oil Company (New Jersey) and a former vice president and director of Esso Standard Oil Company, has been appointed executive assistant to Jersey Standard's chairman of the board. With the Jersey organization since 1936 when he joined Esso Standard's legal staff at Shreveport, Louisiana, Morgan succeeds **George Koegler** who became Jersey's deputy general counsel.

Before joining Esso Standard's legal staff, Morgan served as a U. S. Commissioner in the Western District of Louisiana; as representative and senator in the Louisiana Legislature and as a district judge.

He became a vice president of Esso Standard at Baton Rouge in 1949 and transferred to New York in 1952 after his election to the Esso Standard board.

Arthur L. Baron, with Esso Research and Engineering Company at Linden, N. J., has scored first place in the AIChE's annual student contest. The problem this year was to evaluate a solvent-recovery problem with a simple-distillation process. Baron is a recent Cooper-Union graduate.

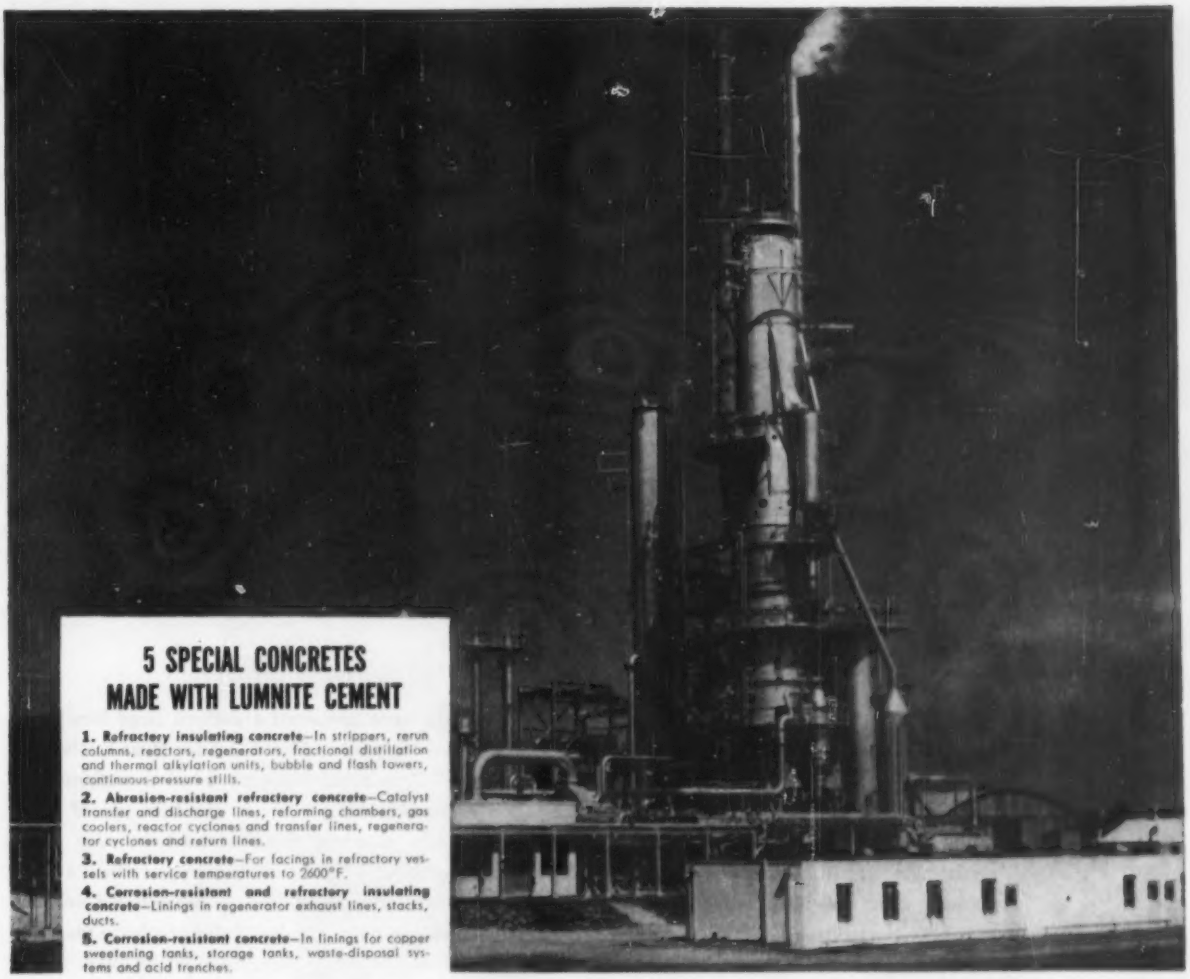
The second-prize winner was **John C. Zahner,** who is completing courses at the University of Illinois. **Ronald L. Hartman,** who will join Shell Oil Company at its Norco, La., refinery, placed third in the contest.

Honorable mention went to **Leon Lehman,** who is studying at the University of Michigan; **Gene M. Pettingill,** a University of Colorado graduate now with Du Pont Company, and **Paul E. Otto,** who attended Louisiana State University and now is also with DuPont.

Robert Lamar Pigford, chairman of the Chemical Engineering department at the University of Delaware, is the recipient of the Professional Progress Award in Chemical Engineering, sponsord by Celanese Corporation of America and administered by AIChE. The award came as recognition of his "leadership in the engineering science approach to the education of chemical engineers and through example, in the practice of chemical engineering."

George R. Ferguson, formerly general manager of California Texas Oil Company's Far East division, has been appointed general manager of a newly-formed North Europe division. He will be replaced in the Far East by **William E. Murray,** with the company many years in the Orient.

Named as general manager of a new South European division is **William Schwarz,** formerly Caltex shareholders representative in Italy. His division covers Austria, Cyprus, Gibraltar, Greece, Italy,


5 SPECIAL CONCRETES
MADE WITH LUMNITE CEMENT
1. Refractory insulating concrete—In strippers, rerun columns, reactors, regenerators, fractional distillation and thermal alkylation units, bubble and flash towers, continuous-pressure stills.
2. Abrasion-resistant refractory concrete—Catalyst transfer and discharge lines, reforming chambers, gas coolers, reactor cyclones and transfer lines, regenerator cyclones and return lines.
3. Refractory concrete—For facings in refractory vessels with service temperatures to 2600°F.
4. Corrosion-resistant and refractory insulating concrete—Linings in regenerator exhaust lines, stacks, ducts.
5. Corrosion-resistant concrete—In linings for copper sweetening tanks, storage tanks, waste-disposal systems and acid trenches.

UOP Fluid Catalytic Cracking Unit, McMurrey Refining Co., Tyler, Texas

Which of these concretes can save you the most time and money?

Industrial concretes made with Lumnite* resist heat . . . resist corrosion . . . *and* insulate!

Solve heat, corrosion and insulation problems in your refinery with concretes made with Lumnite calcium-aluminate cement. Placement is fast and easy—by plastering, pouring or guniting. You'll make rapid repairs because special Lumnite-made concretes reach service strength within 24 hours!

And for even greater convenience, try castables. Packaged castable mixes containing Lumnite cement and selected aggregates assure the right concretes for a wide variety of refinery applications. All you do is add water, mix and place. Castables are made and distributed by leading manufacturers of refractories.

Chances are *all five* of these Lumnite-made industrial concretes can save time and money for you. Check the list above to see where each one can do the best job in *your* refinery. And write today for detailed information on industrial concretes made with Lumnite cement.

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

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ALUMINUM

...the heat exchanger tubing that COSTS LESS, resists corrosion, provides maximum heat transfer

Two important advantages of aluminum make it the natural choice for heat exchanger tubing for most applications. The charts below illustrate cost savings and length of life that aluminum offers. In addition, aluminum heat exchanger tubing provides improved heat transfer rates due to its exceptional non-fouling characteristics.

To help you put these advantages to work in your heat exchanger operations, Reynolds engineers have prepared a sixteen page brochure titled "Reynolds Aluminum for Heat Exchangers." This booklet covers detailed engineering information necessary to the best use of aluminum in many types of heat transfer. The brochure, dealing with some of the varied application possibilities, is reproduced on the adjoining page. Copies of the brochure may be obtained by using the coupon in the lower right hand corner of this advertisement.

See Reynolds New Program "Frontier"—Sundays on NBC-TV.

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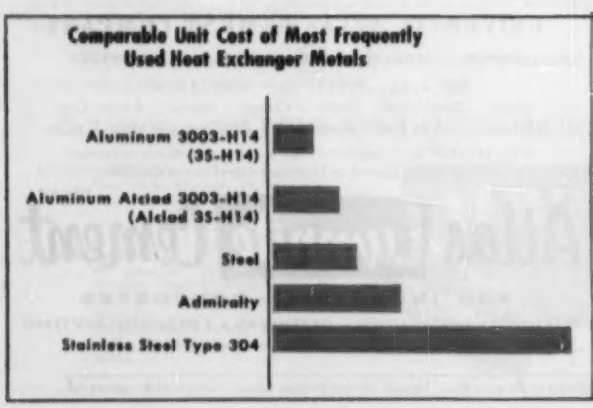
Comparable Unit Cost of Most Frequently Used Heat Exchanger Metals
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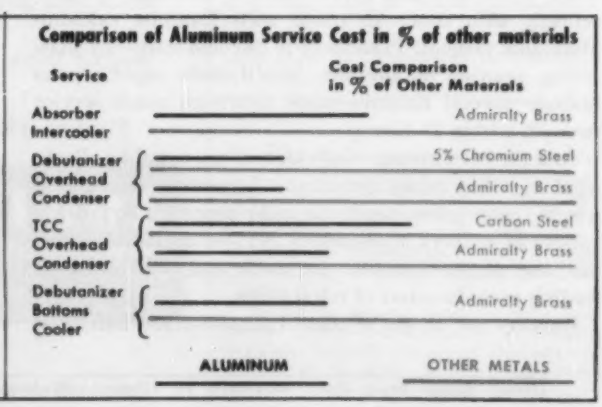
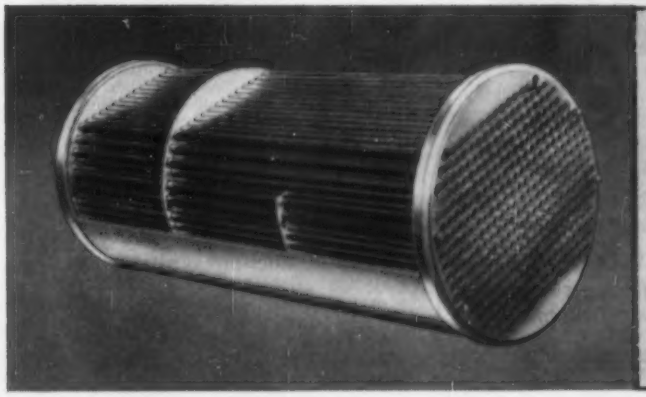
Aluminum Alclad 3003-H14 (Alclad 35-H14)
Steel
Admiralty
Stainless Steel Type 304



ALUMINUM



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Please send me your 16-page brochure entitled "Reynolds Aluminum for Heat Exchangers"

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Company_____ Title_____

Street Address_____

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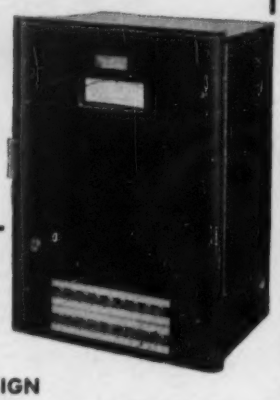
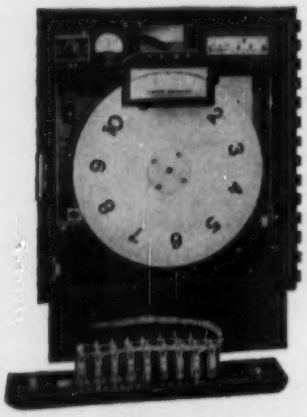
ANOTHER NEW T-E INSTRUMENT—
A SELF-BALANCING INDICATOR WITH BUILT-IN KEY-TYPE OR PUSH-BUTTON SWITCHES.



FUNCTION

To check rapidly and accurately the temperatures at numerous points in any process.



Interior view of indicator with hinged cover removed and key switch panel opened to show details of construction.

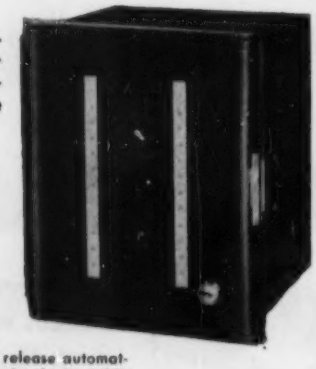
DESIGN

This instrument incorporates a simple electronic continuous balancing system with only two moving parts. Twenty-three scale ranges are provided: from −320° to +200°F. up to 0° to 3000°F. Accuracy is ±¼ of 1% of scale range . . . sensitivity is 1/20 of 1% of the range. Automatic cold-junction compensation is provided.

The maximum capacity of the indicator with built-in key switches is 48 points for thermocouple use and 36 points for resistance bulbs. With push-button switches the maximum is 24 points for either thermocouples or resistance bulbs.

OPERATION

Read scale at hairline in window . . . the next reading will be ready before you can log the last measurement. Balancing speed for full scale deflection is four seconds.



Write Today For Catalog 61-X For Complete Details.

New T-E Push-Button Selector Switch Unit with capacities up to 36 thermocouples or resistance bulbs. A larger case with capacities up to 72 sensing elements is available.

Features self-locking push-buttons that release automatically when any other button is pushed. Also possible to obtain average temperature readings over several points by depressing the buttons simultaneously.

Pyrometers • Temperature Monitoring Systems • Thermocouples • Protection Tubes
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What's Happening. . .

Portugal, Spain, Tangiers, Turkey and Yugoslavia.

The North European division consists of the United Kingdom and Ireland, Algeria, the Azores, Iceland, Tunisia, Scandinavia, the Benelux countries, Finland, France, Germany and Switzerland.

S. H. Kuhn, who has been with Caltex and predecessor companies 35 years, was named general manager of the company's Australasian division.

R. W. McOmie, manager of Shell Oil Company's new Anacortes, Wash., refinery, has been appointed general manager of refineries and assigned to the company's head offices in New York. He will be replaced at Anacortes by **R. C. Barton**, now superintendent of the refinery.

McOmie joined Shell in 1927 as a chemist at its Martinez, Calif., refinery. He progressed through various West Coast positions, and in 1943 was named assistant refinery manager at Wilmington, Calif. He was appointed manager there in 1946, and held that position until he was assigned to the new Anacortes plant.

Barton has been with the company since 1934. After serving in a number of technical and operating positions, he was appointed superintendent of the Martinez refinery in 1949. That was the post he held when he was transferred to Anacortes.

He will be succeeded as Anacortes refinery superintendent by **J. B. Wyman**, now assistant manager of Shell's New York Manufacturing Operations department.

In other changes in the company's Manufacturing department, **L. R. Goldsmith**, manager of manufacturing, will become general manager of the technical departments.

George H. Fremon has been appointed patent coordinator for Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. He will headquarter in the company's New York offices, working closely with all groups in the company concerned with patent matters.

Fremon joined Carbide and Carbon in 1937, and participated in much of the pioneering work on the development of vinyl polymerization techniques and the evalution and application development of vinyl resins. More recently he has concentrated on the development of new synthetic acrylic fibers.

Clayton F. Ruebensaal, author of the article appearing on page 120, has been appointed manager of commercial planning for Texas-U. S. Chemical Company. He formerly was manager of commercial development for Naugatuck Chemical division, United States Rubber Company. Texas-U. S. is equally owned by the rubber company and The Texas Company.

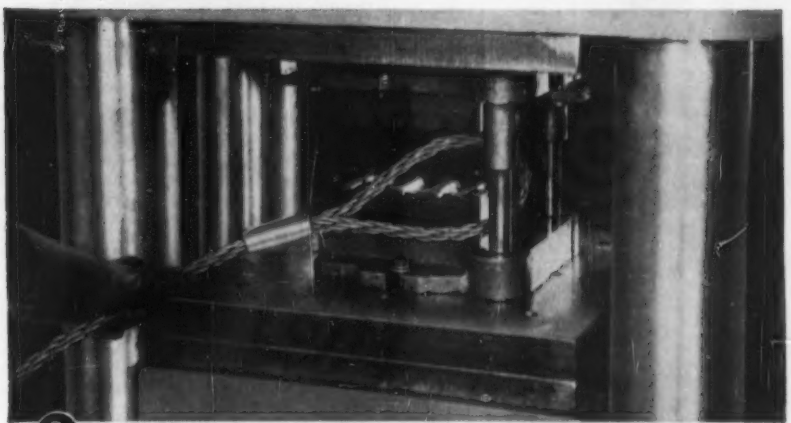
Ray P. Teele, a member of the Photometry and Colorimetry section of the Bureau of Standards, has been appointed a member of the National Research Council.

Walter Gordon Whitman has been elected president of the AIChE. He is conference secretary-general of the United Nations International Conference on Peaceful Uses of Atomic Energy and a professor and head of the Chemical Engineering department at Massachusetts Institute of

Tuffy® SLING NEWS

Vol. 1 — Published Monthly in Leading American Trade Magazines by Union Wire Rope Corp. — No. 2

NEW Tuffy® FERRULE GIVES EYE SPLICE STRENGTH OF Tuffy® SLING FABRIC



1 **TREMENDOUS PRESSURE** of this machine in swaging Tuffy's smooth-edged metal ferrule around the tuck splice virtually flows the metal into the braided fabric interstices.

No Increase in Cost For Smoother, Safer Factory Ferrule Splice

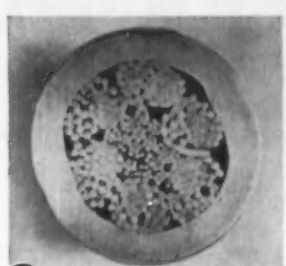
In the most important sling development since Tuffy machine braided wire was introduced, Tuffy now offers sling users greater safety, faster sling handling, and more sling-eye strength—at no increase in price.

It's all made possible by a new steel ferrule used on all Tuffy Slings. This ferrule, slipped over the splice of the eye and pressed on under great pressure, holds so tight that it gives the eye of the sling 100 per cent of the strength of the machine braided wire fabric. The tucked-in splice is completely covered—the swaged ends of the ferrule leave no abrupt edges to catch on loads or to injure workers' hands.

Teamed up with the Tuffy machine braided sling fabric, this new ferrule makes Tuffy the sling handler's favorite for every job.

Good Man To Know— Your Tuffy Distributor

Tell him your requirements. Then let him save you the time, trouble, and money of carrying an inventory. He will stock the Tuffy Slings you want and Tuffy Hoist Lines to team up with your Tuffy Slings.



2 The force of friction set up by compressing the ferrule metal on more of the wire fabric surface forms an eye that really stays spliced.

New Tuffy Sling Handbook FREE — Mail Coupon Now

This big 60-page book tells you all about new factory-fitted Tuffy Slings with our pressed-on ferrule and contains complete information about a full line of factory-fitted Tuffy Slings, nearly a dozen new standard fittings, and complete data and charts on all Tuffy Slings. It also has a brand-new engineer's notebook and a valuable rigger's manual. Send for your copy now. No obligation.

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NEW WAY TO

REDUCE STEAM COSTS

AND INCREASE PRODUCTION

☐ Here is a new steam trap that meets all operating conditions!

The Strong Hydro-Flex Steam Trap performs efficiently under light loads yet gives the same high standard of performance under heavy flow, also greater discharge capacity when needed.

We guarantee your steam system will improve with Hydro-Flex. Outstanding plus-features include: a dual fulcrum arrangement that snaps the valve wide open to give unrestricted condensate flow, all stainless steel working parts including one piece deep-drawn stainless steel bucket. The rugged construction features of Hydro-Flex provide long service life with minimum maintenance.

Your local Strong distributor will give you complete information or write us for Bulletin No. SS-40.

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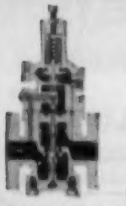
STRONG
HYDRO-FLEX high efficiency under all condensate loads
STEAM TRAPS

HORIZONTAL TYPE SERIES
Hydro-Flex traps with horizontal inlet have the same features as bottom inlet types.

Available from over 200 industrial distributors in the United States, Canada and Foreign Countries.



3 types available for wide range application . . . to meet pressure and capacity requirements.

PRESSURE REGULATING VALVES

are custom sized for job demands. Bolted body permits non-threaded seats and wide selection of seat sizes.

BLOW-DOWN VALVES

STRONG STRAINERS
Offer maximum protection from dirt, scale or sediment. Available in semi steel, cast steel and bronze.

What's Happening. . .

Technology. Since 1951, Dr. Whitman has been chairman of the Research and Development board of the Department of Defense.

Edgar L. Piret, professor of chemical engineering at the University of Minnesota, has ben chosen to receive the AIChE's William H. Walker Award. A specialist in the fields of staged reactors and crushing of solid substances, Dr. Piret was cited for his publication record.

He has contributed some 40 papers and patents on continuous reactor theory and design, leaching, heat transfer, fermentation, high-vacuum transfer operations and engineering education. They have been published in French, German and Finnish, as well as English.

Richard F. Brown, newly-elected vice president in charge of operations for Southern Nitrogen Company, heads a list of six new directors elected to the board of the Savannah, Ga., concern. The new company is building a $14-million petrochemical plant in Savannah.

Other new members of the board are **Donald Stuart Russell,** president of the University of South Carolina; **Richard H. Samuels,** vice president of Continental Casualty Company; **Franz Schneider,** former executive vice president and chairman of the executive committee of Newmont Mining Corporation; **James A. Lyles,** vice president of the First Boston Corporation, and **W. W. Foshay,** an attorney.

Also serving as directors are **Malcolm Smith,** chairman; **John R. Riley,** president, and **George V. Taylor,** executive vice president.

H. G. Vesper, vice president of Standard Oil Company of California, received an API Certificate of Appreciation at the Division of Refining session held in San Francisco. With the company since 1922, he was elected president of the subsidiary California Research Corporation in 1945.

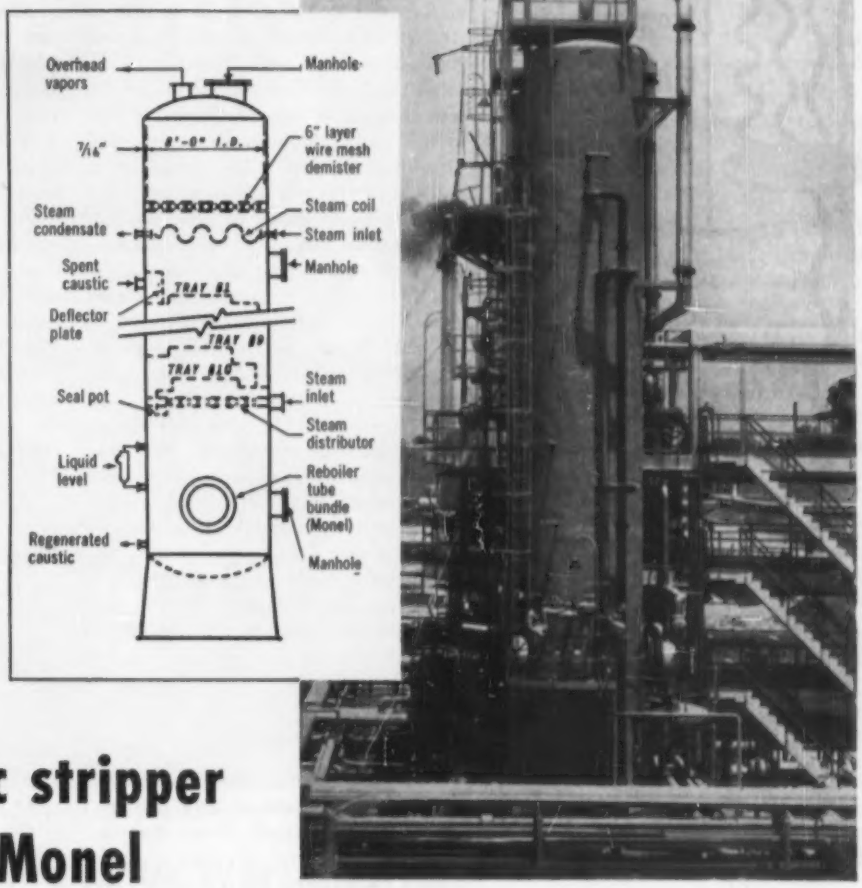
Deaths—

Harold M. Davidson, retired refining coordinator for Standard Vacuum Oil Company, died November 16 at Morristown, N. J., of a coronary thrombosis. He was 59 years old. He served as Stanvac's refining coordinator for 10 years prior to his retirement. He was one of three company executives to escape from the Palembang, Sumatra, refinery before the Japanese occupation in 1942.

M. A. Abernathy, senior vice president and member of the board of directors of United Gas Corporation, died November 2 at Shreveport, La., following a heart attack. He was 62-years-old. In addition to his duties with United Gas, Abernathy was president of Escambia Bay Chemical Corporation in which United Gas has an interest. The concern is building a petrochemical plant near Pensacola, Fla.

Merle Thorpe, a director of Cities Service Company and former publisher of Nation's Business magazine, died October 31 at Washington, D. C. He was 75-years-old. Thorpe joined Cities Service in 1944 as a director and director of business development.

New solid Monel caustic stripper. Old tower was a conventional Raschig-ring-packed, 9 ft. diam. tower with walls clad or lined to 20 per cent of thickness with Monel nickel-copper alloy. New tower is 8 ft. diam. bubble cap tower with 7/16 in. solid Monel walls and a wire mesh coalescing demister installed above the feed tray. New unit reduces maintenance materially. It eliminates ring dust and reduces caustic carryover, saving about 75,000 lbs. per month. It gives a far "sweeter" product, cutting after-treating reagent use in half. Tower response to process changes is also greatly improved.



New caustic stripper is solid Monel

Cities Service expects big cut in former $20,000 per year average maintenance bill

When a vessel must withstand corrosive 47° Baumé caustic at 290° to 300°F., it needs all the protection it can economically obtain.

That was the conclusion reached by engineers of Cities Service Refining Corporation's Lake Charles refinery when they had to replace the caustic stripper in their Unisol unit. The stripper had originally been built using Monel* nickel-copper alloy claddings or linings comprising up to 20 per cent of the vessel wall thickness. That was when wartime restrictions had made it difficult to obtain sufficient quantities of the solid alloy.

When the decision came to replace it, the design was also revised as operating experience suggested.

Goes right back to Monel

This time Cities Service is using 7/16" solid Monel nickel-copper alloy.

They reason this way. Monel remains one of the most resistant of all materials to conditions encountered in caustic regeneration. The 7/16" wall can be expected to give years of trouble-free service. What's more, solid Monel is easy to fabricate. If repair is needed, a relatively simple welding job will handle it.

Cities Service is also using this nickel-copper alloy for hot caustic lines, heat exchangers and the internal reboiler tube bundle.

Caustic corrosion is seldom a clean cut problem with an easy answer...but nickel or nickel alloys like Monel will usually handle it. That's why Inco's Corrosion Engineering Section is one of the first places to go for advice and suggestions. So if you are having trouble, write today . . . giving full details.

*Registered Trademark

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INCO 50 YEARS OF *Nickel Alloy Progress* PIONEERED BY MONEL 1905-1955

For more data on advertised products, use Readers' Service Cards, last page.

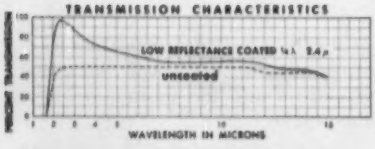
HTL GERMANIUM

Infrared transmission Filters

Of ever increasing importance today, the infrared spectrum offers utilization of ideal frequencies in Process Control Instrumentation, Spectroscopy, and Military Instrumentation. To fulfill the requirements of engineers working in the near infrared region, Houston Technical Laboratories offers single crystal high purity Germanium filters and windows.

The HTL Germanium filter has a short wave length cutoff at 1.7 microns and transmits the near and far regions of the electro-magnetic spectrum. The high refractive index of Germanium lends itself to substantially peaking transmissions at any wavelength (2-10μ) with application of ¼λ low reflectance coating.

In addition to its excellent filtering characteristics, Germanium offers the advantages of being non-toxic and highly resistant to thermal shock.



Write for complete information — specify Optics Bulletin No. 0-103

HTL

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Heard at Meetings . . .

Clean Engines[1]

Superior engine cleanliness, due to the use of a lubricating oil with a new type dispersant were shown by a recent road test. The test, based on the operation of 30 taxicabs driven 50,000 miles each, demonstrated the performance of ten oils containing a variety of types of additives and concentrations in the same base oil. Resulting data also supported by laboratory tests, show that oils vary widely in their ability to prevent sludging under 11w duty operations. The MS-LD (motor severe-low duty) oil containing the new dispersant gave superior engine cleanliness in the road test. The use of MM (motor medium) oils resulted in extremely dirty engines with MS-DG (motor severe-diesel general) and DS (diesel-severe) giving only moderately clean engines in this severe low duty type driving. These same oils evaluated in laboratory engine tests gave correlating results in most cases. (R. I. Potter, Ford Motor Company.)

Pass Resolutions[2]

Three resolutions were passed. The first was opposition to any increase in the price of crude. Since association members purchase most of their crude, they have been caught between rising domestic prices in crude and importation of foreign crude by major oil companies.

The second resolution was to make known to government that small refiners have not been permitted to participate in government secret research on developments that have critical import on petroleum refining. It was emphasized that the government is in favor of keeping the independent in business because of plant dispersal; but the independent can only stay alive if he also participates in government research developments.

The third resolution favored more publicity on the aims of the association so that the independents who are not members may become acquainted with the organization.

[1] SAE, National Fuels and Lubricants Meeting, Philadelphia, November 9-10.

[2] IRAA, San Francisco, November 16.

Worlds to Conquer[3]

Mechanical engineers looking for new worlds to conquer will find plenty of challenges in the petroleum industry, all the way from the drilling field to the gasoline station pump. The further progress of the petroleum industry will continue to depend heavily on advances in mechanical engineering. Much of the technical advances will be contributed by industries other than petroleum, and it will be the petroleum mechanical engineer's job to apply them to petroleum technology. Every branch of the petroleum industry will need the creative and constructive ability of the engineer. (Eugene W. Jacobson, Gulf Research and Development Company, Pittsburgh.)

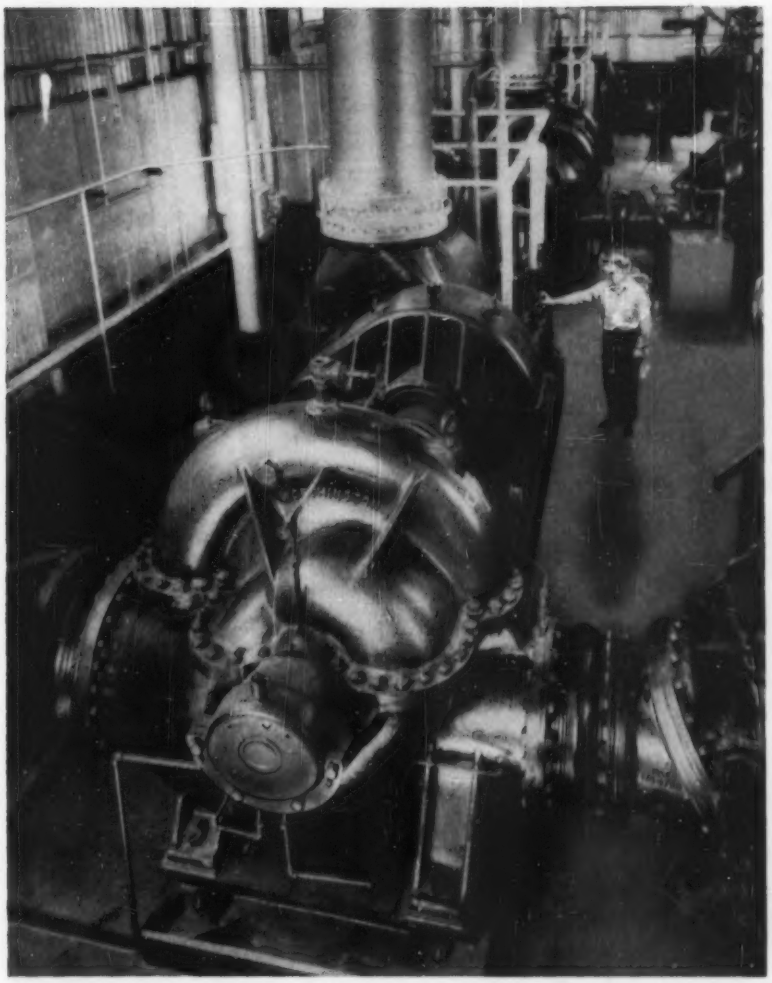
Nuclear Engineering[4]

Chemical engineers, both graduate and undergraduate, taking the one-semester introductory terminal course at Purdue lack a background in nuclear physics and advanced mathematics. This handicap has been partially overcome by the rapid presentation of background physics on a "sink-or-swim" basis with an emphasis on assigned problems requiring supplemental reading for solution. A minimum of about 12 meetings seems necessary to cover the essentials of nuclear and neutron physics required for some understanding of reactor engineering variables. (Alexander Sesonske, Purdue University.)

Nuclear engineering courses, since 1950, have been offered at Columbia as graduate electives to students in the regular departments. This program emphasized a one-term, evening, two-point graduate level survey, "Introduction to Nuclear Reactor Technology." In this course, the pertinent principles which every engineering curriculum does not include, were briefly presented and illustrated by specialists, both in the classroom and in homework. To cover the nuclear field with minimum reason-

[3] ASME Diamond Jubilee Annual Meeting, Chicago, November 13-18.

[4] AIChE, Detroit, November 27-30.



Three Worthington horizontal centrifugal pumps at Gulf Coast refinery.

Gulf Coast refinery picks Worthington horizontal centrifugal water pumps

In oil refining operations you've got two strikes against you if you can't count on a dependable general water supply.

You need water for cooling towers, general service, engine and compressor cooling, heat exchangers and condensers. And water must be available 24 hours a day to eliminate costly down-time.

That's why a Gulf Coast oil company picked three Worthington turbine-driven horizontal centrifugal pumps *(above)* for water in their Texas refinery. These units operate continuously at rated capacity, head and efficiency.

The easy accessibility for inspection and maintenance, the 24-hour dependability and sustained performance of these pumps reflect Worthington's experience with refinery pumping problems.

Why a horizontal pump?

Here are five big reasons for installing a Worthington horizontal centrifugal pump:

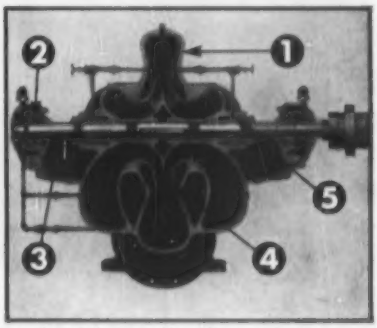
1. **Casing** — horizontally split. Upper half lifts off to allow inspection and maintenance.

2. **Bearings** — double-row ball bearings are easily accessible for servicing and replacement. Location prevents contamination from water being pumped.

3. **Shaft** — easily arranged for dual drive. Shaft may be extended opposite main drive source to accommodate any standby prime mover.

4. **Symmetrical impeller** — balanced axial forces mean negligible thrust loads for low wear, long life. High initial and sustained efficiency.

5. **Stuffing boxes** — under suction pressure and fitted with renewable shaft sleeves.



Horizontal centrifugal pump (cutaway view).

There's a Worthington horizontal centrifugal pump for every purpose. Available with casing, impeller, shaft, shaft sleeve, and wearing rings in bronze, iron or alloys for various water conditions — with standard water-sealed stuffing boxes or mechanical seals. Get all the facts on Worthington horizontal centrifugal pumps for your application — jot down your requirements on your letterhead and we'll send you bulletins on suitable pumps promptly. Write Worthington Corporation, Section C.5.1C, Harrison, N.J.

C.5.1C

WORTHINGTON

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

CENTRIFUGAL • ROTARY • STEAM • POWER • VERTICAL TURBINE

This is what dockmen call flexibility in a hose...

It's a hook-up of U. S. Rubber's H-1515

Notice the snakelike, flexible way this 12" I. D. hose drapes over and around objects on this oil-barge dock. This is one hose that's not bulky, heavy or stiff. It's a dockworker's dream of a hose.

Known as Amazon® H-1515, this United States Rubber Company hose is 2/3 lighter than conventional hose. It is so flexible and easy-to-handle that it sharply reduces make-up time to the header. And naturally, this light weight and extra flexibility reduce accidents. As for durability, U. S. Amazon, despite its light weight, takes rough treatment without damage. *It's in a class by itself.* Its ease of handling, quick make-up time *reduce loading charges.*

U. S. Amazon has been thoroughly proven by five years of Navy service and four years of oil company service. It is now used by every major oil company in America and most foreign countries. Made only by United States Rubber Company and sold through any of the 27 "U. S." District Sales Offices. For more information write address below.

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Who's Meeting . . .

able breadth and graduate-level depth, yielded a very "tough" course. While all students questioned felt they had gained an understanding of reactors and their problems, most said that too much was covered too fast. (Charles F. Bonilla, Columbia University.)

A project is underway at the University of Kansas, which has as its purpose the development of a number of type-problems suitable for use in the usual undergraduate courses in chemical engineering, but which have a nuclear engineering slant. Primary emphasis is on the basic principles of chemical engineering rather than instruction in the details of nuclear engineering. The sources of information employed in this project were given as well as sources for additional problem material. (J. O. Maloney, University of Kansas.)

The basic need for engineers in nuclear technology is for graduates of standard engineering curricula who are especially competent in mathematics. The nuclear theory can be obtained by a graduate degree in a university, from in-service courses, by extension-type courses or by home study. In-service courses at the National Laboratories will doubtless diminish and the job will be taken over by industry or universities or both. Industry should rely on the schools to teach the fundamentals and restrict its in-service courses to review and technology. Nuclear engineers do not need a separate kind of undergraduate instruction but should have graduate instruction if they wish to specialize in reactor design. (Robert M. Boarts, University of Tennessee.)

Technical Societies[5]

Membership in professional organizations is a key step in the development of an engineer. This is particularly important during the current shortage of engineering man-power, because industry finds it necessary to delegrate greater responsibilities to its younger men than ever before. (G. L. Royer, American Cyanamid Company, New York.)

There should be a freer policy of publication by industry because (1)

[5] AIChE, Detroit, November 27-30.

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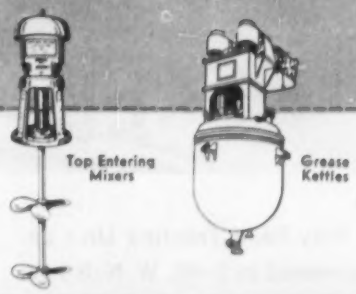
PATTERSON
GREASE MIXERS

Patterson Grease Kettles and Mixers lead the field in heavy lubricant production. Equipped with heavy duty, double motion drive and efficient clean-scraping stirrers. Let us explain the many advantages to you!

Richard L. Cameron
President



Give outstanding performance in blending, sweetening and ethylizing of gasoline, blending of oils, etc.

The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, ATLANTA, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE
The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

For more data on advertised products, use Readers' Service Cards, last page.

Who's Meeting . . .

there is a moral responsibility to repay in kind the information and ideas obtained from the published works of others (2) well-written papers by staff members bring recognition to the company (3) the prestige afforded the author-employee is his just due as a professional (4) technological progress depends on the efficient use of engineering and scientific manpower and wasteful duplication of technical work cannot be tolerated. (J. J. McKetta, University of Texas.)

Employees in every field of the organization derive specific and different benefits from participation in technical society activities. The association with senior professional persons may be the most valuable factor for younger employees, as contributing to their professional development. (Adolph Monsaroff, Monsanto Canada, Ltd., Montreal.)

Technical societies are of assistance to the engineer, his company and industry in general. Are the societies meeting the needs of industry and the individual? What new efforts should be undertaken to meet these needs? (F. J. Van Antwerpen, AIChE, New York.)

Complete Engineering Service...

From Start

The photo at right is a model produced by the C. W. Nofsinger Organization prior to construction of the actual project.

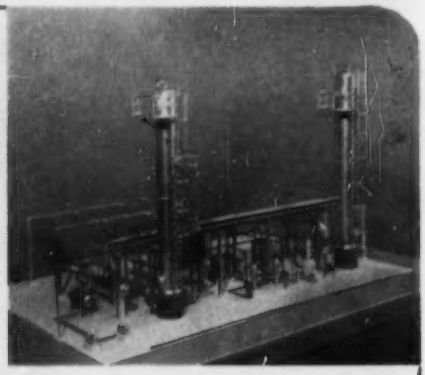
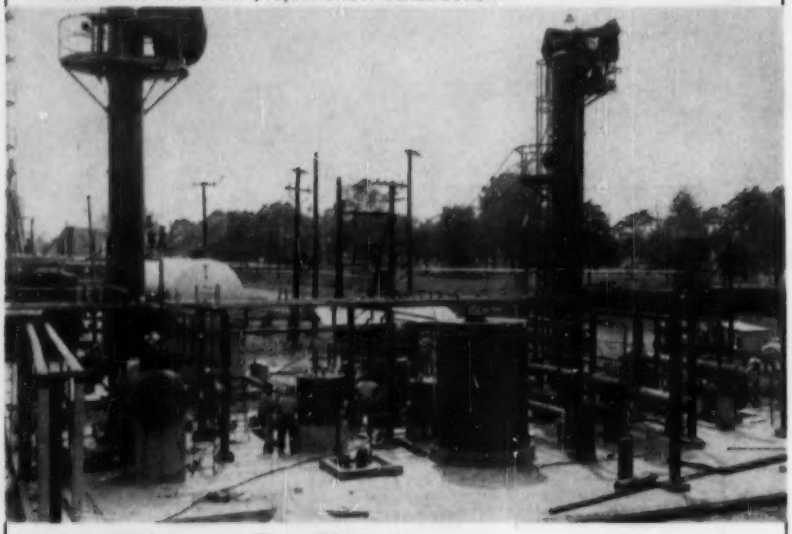


Photo below shows the project under construction.



To Finish

The Catalytic Poly Feed Treating Unit designed and engineered by the C. W. Nofsinger Co. is now in successful operation at Sohio's Lima, Ohio refinery. The unit has a capacity of 2,500 BPSD.

"In Engineering, it's the People that count"

THE C. W. NOFSINGER CO.

Engineers and Contractors for the Petroleum and Chemical Industries

906 Grand Avenue • Kansas City 6, Mo. • Phone BAltimore 1-4146

Rubber and Value[6]

The economic body could be described as having steel bones, petroleum blood and rubber muscle. Before the war, the U. S. had reached a rubber consumption of 750,000 tons a year. This year, the figure is doubled —1,500,000 tons.

The rubber consumption of the whole world this year will be just short of 3,000,000 tons, made up of approximately 2,000,000 tons of natural and 1,000,000 tons of synthetic rubber. The world is using today all the natural that can be produced as well as all the synthetic. World rubber consumption in the next ten years will rise to 4,000,000 tons. Most of this increase will come from synthetic.

The classical definition of value, "Price Plus Quality Equals Value," is still true but today it is modified by several new factors—variety, innovation, convenience, terms, service, style and reputation.

The economy will probably profit more from sales training than any other form of consumer research in the future. An unbeatable team is composed of a good product, good outlets, and a well-trained salesman. (E. J. Thomas, The Goodyear Tire & Rubber Company.)

A Bright Future[7]

An automobile air-conditioner, dumping large quantities of heat under the hood, increases the tendency of a car to vapor lock. It was predicted at first that this situation would require a lower vapor pressure fuel, thus reducing the quantity of natural gasoline used in motor fuel blending. Some are now more optimistic of natural gasoline's future.

It is believed that this situation will actually require the auto industry to design against vapor lock. Such designs might include fuel injection or submerged fuel pumps. If one of these forms of fuel distribution is used, even higher vapor pressure fuels may be used. This would pave the way to greater use of light hydro-

[6] API, San Francisco, November 14, 1955.
[7] NGAA, Shreveport, La., October 28.

For more data on advertised products, use Readers' Service Cards, last page.

A message to PETROLEUM INDUSTRY MANAGEMENT

Here's how you can use

STRATEGIC PURCHASING

to help your company maintain a sound competitive position

As profit margins tighten, your purchasing strategy becomes a vital force for success.

The way you purchase heavy chemicals, for instance, can influence your company's profits in the years ahead.

So it becomes increasingly important for you to seek every possible economic advantage when you select a chemical supplier.

Here, for example, are a few things to look for, when deciding on a source for caustic soda and other chemicals:

1. Supply security. How flexible are your supply lines? For instance, a supplier with plants located on deep water may be able to offer you a choice of rail or water delivery. This can insure you steady supply, in case of rail service interruption.

2. Engineering help. A supplier's engineering staff can often be valuable to you when you are setting up a new chemical process or caustic handling system—not only with advice, but with actual design assistance.

3. Smooth processing. You'll find it helpful to work with the supplier's technical service men who visit you periodically. Often these men can spot potential problems and ward them off before they cause you trouble.

4. Safety programs. Your men can benefit from safety suggestions offered by your supplier. You should have on tap the latest in safety equipment, plus up-to-date information on safe handling of chemicals.

5. Economy. Choose a supplier who wants to help you cut your operating costs; who will go all the way with you in arriving at the best, most advantageous method of shipping and handling for your conditions.

6. Experience. Above all, choose a supplier who is familiar with your industry. It takes years of experience to acquire an understanding of the problems you face, and the know-how to help you solve them quickly and economically.

Are you getting your fair share of these strategic purchasing advantages?

Many of our customers in the petroleum industry feel that they get these advantages in buying from Hooker, a supplier of basic chemical materials to industry for fifty years.

In the light of the growing importance of these factors, isn't this a good time to review your policies on sources of chemical supply?

S-650

HOOKER CHEMICALS

1905—Half a Century of Chemicals
From the Salt of the Earth—1955

HOOKER ELECTROCHEMICAL COMPANY

52 Forty-seventh Street, Niagara Falls, N. Y.

NIAGARA FALLS • TACOMA • MONTAGUE, MICH. • NEW YORK • CHICAGO • LOS ANGELES

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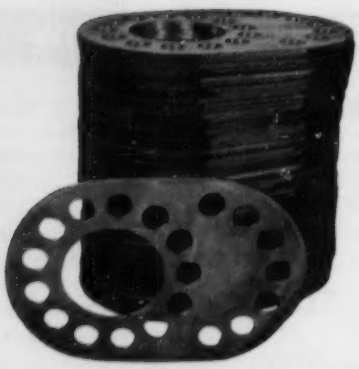

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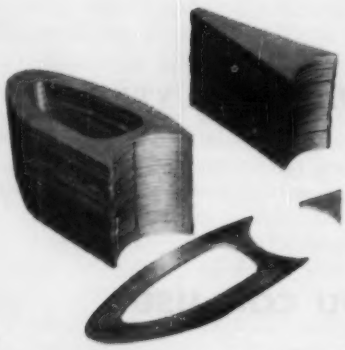

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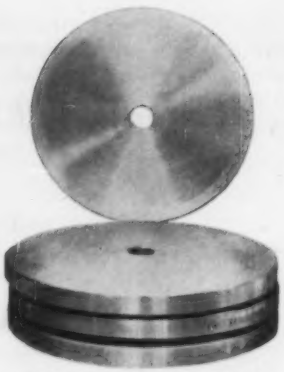
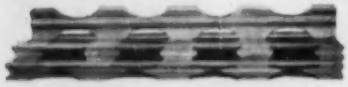
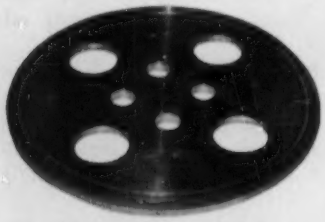


Blank size: 5" thick x 78" OD

Blank size: 4" thick x 7¾" x 71⅜".
Illustrations show before and after machining.



All the products illustrated here were flame cut, sawed, abrasive cut, sheared or machined from stainless steel plate.



Blank size: 2" thick x 60" OD

Stainless steel plate produced to your specifications for quick delivery

Confidence in Carlson service has made G. O. Carlson, Inc. the country's leading specialist in stainless steel plate. As we grew to this position in the industry, we learned and developed new methods of working stainless plate.

What does this mean to you?

It means you can buy for quick delivery exactly what you need in stainless steel plate—sheared, sawed, flame cut, abrasive cut, or machined. And this is true whether the job is a "toughy" or "run of the mill"!

When you need stainless steel plates—special patterns like these or plain rectangles—you'd better try Carlson service, where experience pays off.

write for CARLSON'S WEEKLY STOCK LISTS . . .
YOUR GUIDE TO WHAT'S AVAILABLE
IN QUALITY STAINLESS STEEL

Stainless Steels Exclusively

G. O. CARLSON, INC.

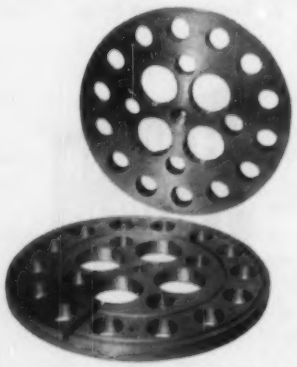
THORNDALE, PENNSYLVANIA

Plates • Plate Products • Forgings • Bars • Sheets (No. 1 Finish)

District Sales Offices in Principal Cities

Blank size: 3⅛" thick x 106½" OD

Blank size: ¼" thick x 75" x 88"



Blank size: 1½" thick x 26" OD

carbons and natural gasoline. (A. H. Weil, United Gas Pipe Line Company, Shreveport, La.)

Management Essentials[8]

Any program for management development should contain these essential features: selection, intellectual conditioning, and practical application. Many of the programs of management development practiced today incorporate only one or two of these. Even then, the emphasis on methods and techniques often obscures the real intention of a development program.

The new approach to intellectual conditioning uses theories rather than particular situations. It tries to develop a philosophy rather than lay down rules. (Willard E. Bennett, labor relations superintendent, Cities Service Refining Corporation, Lake Charles, La.)

[8] WPRA, El Dorado, Ark., October 20-21.

MEETINGS CALENDAR

JAN. 19–20	National Industrial Conference Board, Commodore Hotel, New York.
23–26	Plant Maintenance and Engineering Show, Convention Hall, Philadelphia.
25–26	Northwest Petroleum Association (Annual Convention), Nicollette Hotel, Minneapolis, Minn.
25–27	Instrumentation for the Process Industries Symposium, Sponsored by the Chemical Engineering Department, Texas A&M College, College Station, Texas.
26–27	Plan Maintenance and Engineering Conference, Warwick Hotel, Philadelphia.
30–Feb. 3	American Institute of Electrical Engineers (General Meeting), Hotel Statler, New York.
FEB. 12–18	Statistics Short Course for Industry and Physical Sciences, jointly sponsored by the University of North Carolina, North Carolina State College and The Women's College, at North Carolina State College, Raleigh, N. C.
24	Natural Gasoline Association of America (Regional Meeting), Lincoln Hotel, Odessa, Texas.
26–29	American Institute of Chemical Engineers, Statler Hotel, Los Angeles.
27–Mar. 2	American Society for Testing Materials (Committee Week), Statler Hotel, Buffalo, New York.
MAR. 12–16	National Association of Corrosion Engineers (Annual Convention), Statler Hotel, New York.
19–21	Mid-West Gas Association, Hotel Fontenelle, Omaha, Neb.
19–21	Western Petroleum Refiners Association (Annual Meeting), Plaza Hotel, San Antonio, Texas.
21–23	Annual American Power Conference, Sponsored by Illinois Institute of Technology, Hotel Sherman, Chicago.
APRIL 2–4	American Institute of Electrical Engineers (Southwest District 7), Dallas, Texas.
11–13	Natural Gasoline Association of America (Annual Convention), Texas Hotel, Fort Worth, Texas.
17–19	Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Oklahoma.
18–20	National Petroleum Association (Semi-Annual Meeting), Cleveland Hotel, Cleveland, Ohio.
26–27	American Institute of Electrical Engineers (National Meeting), Bradford Hotel, Boston.
30–May 4	American Petroleum Institute (Safety and Fire Protection Mid-Year Meeting), Warwick Hotel, Philadelphia.
MAY 6–9	Liquefied Petroleum Gas Association (Convention and Trade Show), Conrad Hilton Hotel, Chicago.
6–9	American Institute of Chemical Engineers, Roosevelt Hotel, New Orleans.
14–17	American Petroleum Institute, Division of Refining (Mid-Year Meeting), Sheraton-Mount Royal Hotel, Montreal, Canada.
JUNE 17–22	American Society for Testing Materials (Annual Meeting and Apparatus Exhibit), Chalfonte-Haddon Hall, Atlantic City, N.J.

Who's Meeting . . .

In the Future . . .

Plant Maintenance and Engineering Show will be held in Philadelphia January 23-26. The seventh National Plant Maintenance Conference will be held at the Warwick Hotel there January 23-25, with executive study groups meeting January 26-27. The meetings will take up the complete maintenance picture for all kinds of plants. Maintenance engineers from every industry are expected to attend.

TENNESSEE'S
SO2
LIQUID
SULFUR DIOXIDE
A
SOLVENT
OF
Proven Merit
Tennessee's Liquid Sulfur Dioxide is particularly suitable as a solvent for recovery of aromatics. It is completely miscible with aromatic hydrocarbons over a very wide temperature range, while the solubility of naphthene and paraffin hydrocarbons is limited and decreases with decreasing temperature. Recovery of a higher percentage of aromatics is obtained for hydrocarbons over a wide boiling range.
Tennessee's highest quality Liquid Sulfur Dioxide can be effectively and economically applied to your operation. We would like to discuss this with you.
SULFUR-DIOXIDE
HIGHEST QUALITY
SO2
AVAILABLE IN: Cylinders, Ton Drums, Tank Trucks and Tank Cars
TENNESSEE TC CORPORATION
617-629 Grant Building, Atlanta, Georgia

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Rich | Ley | Lovett | Tivy | Edwards | Pullen

Frederick S. Rich, formerly senior instrument engineer for Arabian American Oil Company, has been appointed petroleum industry coordinator for **Fischer & Porter Company.** Before joining Arabian American Oil he was senior instrument engineer for Arthur G. McKee & Company and prior to that was instrument supervisor for Carbide & Chemical Company at Oak Ridge. He also worked at Aruba, N.W.I., for Standard Oil Company (New Jersey).

Gordon Ley has been appointed district representative serving the Colorado area for **Electric Steel Foundry Company.** His appointment follows an expansion of the company's Utah-Colorado sales force. **Garland Allen,** manager of the Salt Lake branch, now will devote full time to the Utah and southern Idaho area. Ley has been with ESCO 15 years, the last six of which he served as a specialist in processing equipment.

Walter Lovett, who is a former assistant professor of civil engineering at the University of Pittsburgh, has been named as manager of a newly-created Technical Service department of **Pittsburgh Corning Corporation.** He has been associated with the company since 1950.

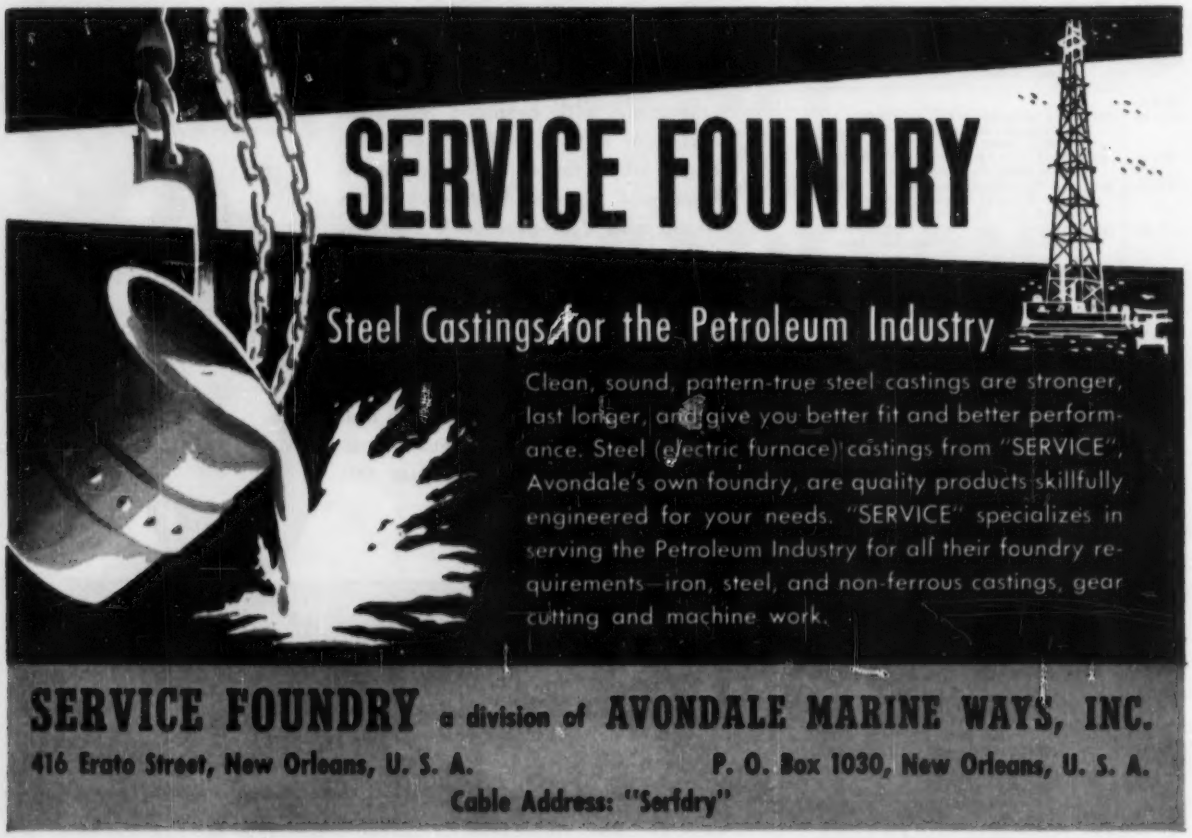
Vincent V. Tivy, formerly manager of refinery instrument sales for **The Foxboro Company,** recently was appointed the firm's chief application engineer, responsible for coordinating sales engineering with product development and production engineering activities. He also will serve on Foxboro's Engineering Executive and Sales Product committees.

Arthur C. Edwards has been appointed field engineer by **Chiksan Company.** In addition to his sales duties, he will handle special assignments and projects. Edwards joined Chiksan in 1946 as a design and tool engineer, and two years later was named senior salesman handling field-engineering problems. He succeeds **H. J. Schlarb** in the Los Angeles area.

R. W. Pullen, a district sales engineer for **Byron Jackson Division of Borg-Warner Corporation,** has been transferred to Dallas. With the company since 1952, he recently was district sales engineer for Byron Jackson at Memphis. He was transferred because of expanding activities in the Dallas area.

Albert H. Clarke, commercial vice president of **Crouse-Hinds Company,** has been named vice president in charge of engineering. He succeeds **Carl H. Bissell,** who is retiring after 53 years of company service. Clarke, with the company since 1925, became commercial vice president in 1952. He served as illumination manager.

L. D. Craggs is appointed assistant construction machinery sales manager at the Dallas branch for the Construction Machinery division, Tractor group, **Allis-Chalmers Manufacturing Company.** He was with Baker Manufacturing Company in the Dallas territory when it was ac-


SERVICE FOUNDRY
Steel Castings for the Petroleum Industry
Clean, sound, pattern-true steel castings are stronger, last longer, and give you better fit and better performance. Steel (electric furnace) castings from "SERVICE", Avondale's own foundry, are quality products skillfully engineered for your needs. "SERVICE" specializes in serving the Petroleum Industry for all their foundry requirements—iron, steel, and non-ferrous castings, gear cutting and machine work.
SERVICE FOUNDRY a division of AVONDALE MARINE WAYS, INC.
416 Erato Street, New Orleans, U. S. A.
P. O. Box 1030, New Orleans, U. S. A.
Cable Address: "Serfdry"

LIFELINE FOR A REFINERY

This thin loop of copper tubing is the mark of a refinery that has learned to combat corrosion and fouling the modern Polyrad way. This is the injection line for Polyrad—and it can well be called the "lifeline" for refinery equipment.

Polyrad is a filming amine that acts both as an inhibitor and detergent. Its detergency maintains throughput, increases heat transfer, and cuts down time for maintenance. At turn-around time you really see the difference—Polyrad—protected bundles are free of corrosion, ready for immediate return to service.

Stocks of Polyrad are maintained throughout the country. A Hercules trained representative will be glad to discuss its application to your specific operating conditions.

Pine Chemicals Division, Naval Stores Department

HERCULES POWDER COMPANY

INCORPORATED

976 Market Street, Wilmington 99, Del.

POLYRAD®

FILMING AMINE INHIBITOR

NA55-6

For more data on advertised products, use Readers' Service Cards, last page.

IF YOU'RE IN A HOLE OVER

THICKER AND BIGGER SHELLS . . .

KELLOGG'S EXPANDED FABRICATING FACILITIES CAN HELP YOU OUT

Why let shell geometry present a production bottleneck on urgently needed heat exchangers, towers, and other pressure vessels? M. W. Kellogg's expanded and complete fabricating facilities are geared to produce shells thicker, bigger, and in shorter time than ever before.

Production tools recently installed at Kellogg's New Jersey shop to meet increasing demands for larger vessels include: a planer capable of handling steel plate 40 feet long; huge bending rolls, augmented by a new, ancillary 2,000-ton press for bending plate up to 4 inches thick; and automatic welding equipment for longitudinal seams to 16 feet in length, and circular seams 12 feet in diameter.

In heat treating, Kellogg now can handle vessels larger than a railroad car, with thirteen furnaces having temperature ranges from 1200 to 1950 deg. F. Its pipe bending facilities can shape carbon steel and alloy piping 36 inches in diameter—to exceptionally close tolerances. In nondestructive testing, Kellogg's latest addition is its Kel-Ray* Projector. Using gamma rays, this unique instrument permits the radiographic inspection of welded seams as thick as 6 inches in a single short exposure.

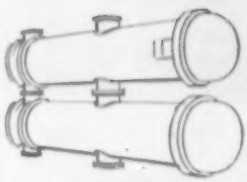
Backing up Kellogg's fabricating facilities are Kellogg engineers, who can either assume entire design responsibility or work closely with your own engineers; and Kellogg's staff of fabricating-welding engineers, who plan and administer a continuing personnel training program to qualify welders and mechanics on new techniques for fabricating new materials.

We welcome the opportunity to demonstrate what Kellogg's complete engineering and expanded fabricating service can do for *you*.

FABRICATED PRODUCTS DIVISION
THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.
In Canada: The Canadian Kellogg Company, Limited, Toronto
In Europe: Kellogg International Corporation, London
SUBSIDIARIES OF PULLMAN INCORPORATED

*Trademark of The M. W. Kellogg Company

ENGINEERED FABRICATION BY KELLOGG



HEAT TRANSFER EQUIPMENT

TANKS AND REACTORS

KNOCKDOWN VESSELS

PROCESS PIPING

PRESSURE VESSELS

For more data on advertised products, use Readers' Service Cards, last page.

Clarke Craggs Guyette McNeely Jones Wall

quired by Allis-Chalmers early this year. He started with Baker Company in 1947.

Frederick L. Guyette, with **The New York Air Brake Company,** has been made chief plant and equipment engineer. He has served the company in various manufacturing capacities for 25 years. In his new position, Guyette will be responsible for plant layout, machine tools, buildings and equipment.

Branch M. McNeely, Jr., has joined the Development and Research division of **The International Nickel Company, Inc.,** as a member of the Texas Technical Field section with headquarters in Houston. He formerly was connected with Houston Oil Field Material Company as assistant chief engineer.

Ivan A. Jones, district representative for **U. S. Steel Corporation's** Oil Well Supply Division, has been transferred from Eldorado, Kansas to Wewoka, Okla. With the company since 1948, he served at Great Bend and Ellinwood, Kansas, and took over as district representative at Eldorado in 1952.

Thomas P. Wall has been made general manager of **Rockwell Manufacturing Company of Canada, Ltd.** Formerly manager of the Toronto branch of Peacock Brothers, Ltd., he will assume most of the duties of **W. W. Brydges,** who is retiring as president of the Rockwell Manufacturing Company subsidiary.

Allied Chemical & Dye Corporation's General Chemical division has scheduled a major expansion of the sulfuric acid production facilities of its East St. Louis, Ill., works. The plant's capacity is being stepped up over 35 per cent. Construction, already started, is scheduled for completion by March, 1956.

Air Reduction Sales Company has appointed **W. M. Champion** as district manager of its Shreveport, La., sales office. Champion, replacing John Lund who left the company, has been with Airco since 1946, serving in various sales capacities at the Oklahoma City office. Since July 1954, he held the position of assistant sales manager there.

Suppliers . . .

Harbison-Walker Refractories Company has purchased an interest in Fabrica de Ladrillos Industriales y Refractarios, S. A., (Flir) of Mexico. The firm is a subsidiary of Cia. Fundidora de Fierro y Acero de Monterrey, S. A. It is planned to change the name to Harbison-Walker-Flir, S. A.

Harbison-Walker-Flir, S. A. is expected to supply a substantial share of the refractories requirements of Mexican industry. The firm produces fireclay and silica refractories in a modern plant at Monterrey, Mexico. The plant now is in process of enlargement.

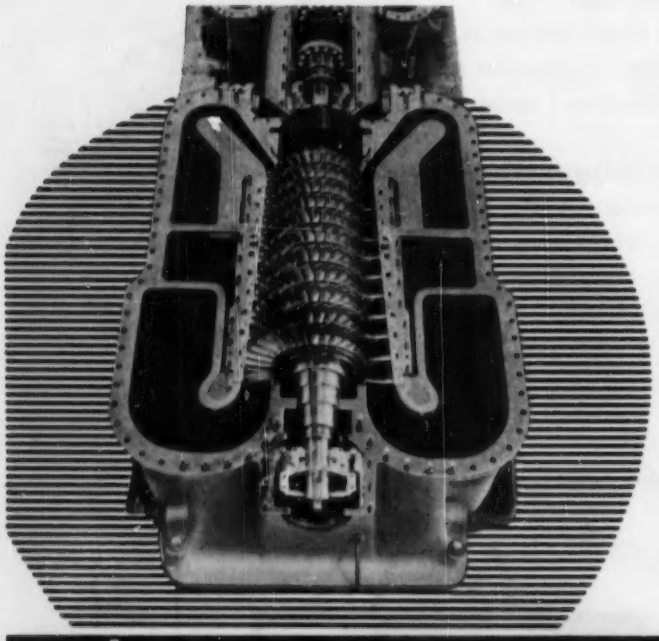
Downingtown Iron Works, Inc., has appointed **Frank L. Rubin** as a member of its sales engineering force. Rubin, known for his articles on heat-transfer design, formerly was with Catalytic Construction Corporation.

Rubin

He has a background of some 15 years with the chemical, petrochemical, petroleum and power industries. Most of that time has been spent in the design of heat-transfer equipment.

For the past three years, Rubin has served as a senior job engineer with special emphasis on heat-transfer problems. His work was on AEC projects, chemical plants and refineries.

He is author of three technical papers on heat exchanger costs and design, and



GHH
Axial Flow Blower

GAS CIRCULATORS
COMPRESSORS
EXPANDERS
PRESSURE VESSELS
HEAT EXCHANGERS
COLUMNS

GUTEHOFFNUNGSHÜTTE
STERKRADE AKTIENGESELLSCHAFT · STERKRADE WORKS · GERMANY

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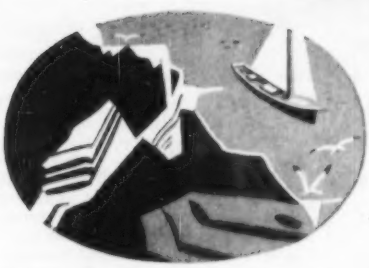
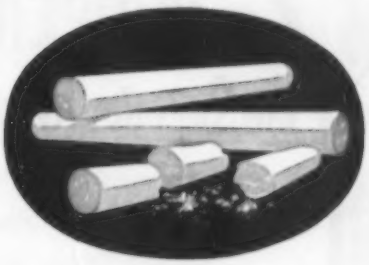
15 Moore Street, New York 4, N. Y. • Telephone WHitehall 3-8241

HARSHAW
Tableted
CATALYSTS

FROM **strong** TO *soft*





as rock! *as chalk!*

whatever you specify

Typical Harshaw Catalysts:

Aluminum Chloride Anhydrous
Boron Trifluoride
Boron Fluoride Addition Compounds
Hydrofluoric Acid Anhydrous
Alumina—active or inert
Chrome Alumina
Molybdena Alumina
Tungsten Alumina
Cobalt Molybdena Alumina
Copper-Chromium Oxide
Magnesia
Nickel
Vanadium
Zinc-Chrome

Harshaw Catalysts available in these forms:

Tablets
Extrusions
Powders
Granules
Spheres
Rings
Flakes

Use Harshaw Catalysts for these processes:

Hydroforming
Cyclization
Oxidation
Dehydrogenation
Hydrogenation
Dehydration
Desulphurization
Alkylation
Isomerization

Harshaw Catalysts—made exactly to your specifications of raw materials, chemical composition, and physical properties such as length, diameter, crushing strength, abrasion resistance, bulk density, etc. *AND* delivered *when you want them!*

Harshaw has the know-how—we pioneered in making customer specified catalysts. Harshaw has the facilities—we produce *carloads* every week!

We are to you like the druggist is to the doctor . . . write your catalyst prescription and depend on Harshaw to fill it.

Our free booklet "Harshaw Catalysts" is yours for the asking. Write today.

The HARSHAW CHEMICAL Co.

CLEVELAND 6, OHIO

CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES
HASTINGS-ON-HUDSON • PHILADELPHIA • PITTSBURGH

Suppliers . . .

heat transfer design data. He also has written five instruction manuals on heat-transfer equipment, and serves as a reviewer of heat-transfer papers for the AIChE.

Refinery Engineering Company has appointed two new vice presidents. They are **H. V. Flemming, Jr.**, formerly sales manager and now vice president in charge of sales, and **Paul H. Smith**, chief estimator moved up to vice president in charge of construction.

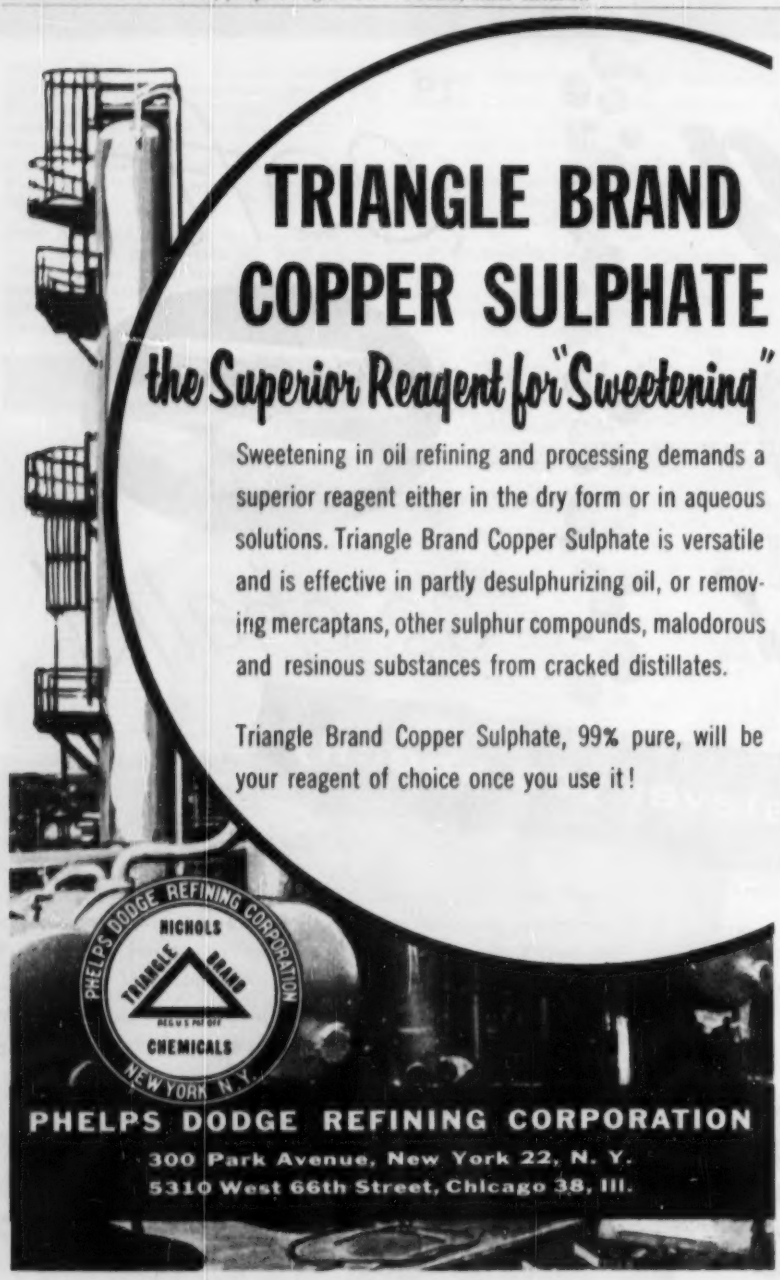
Other new appointments in the organization include: **D. F. Ferguson**, process development engineer; **D. B. Crawford**, chief estimator, and **W. L. White, D. R. Turner** and **L. D. Travis**, project engineers.

L. O. B. Glass Fibers has created a Combined Customer Service department, with **Raymond Petersen** as its manager. The new department combines the service facilities of the General Products and Textile divisions of the firm.

Working with Petersen will be **George C. Arnold, A. J. White, John M. Vanselow** and **William F. Moll, Jr.**

Hercules Powder Company has made **Wilbur E. Becker** plant manager at the tall oil plant at Franklin, Va. Becker succeeds **Spencer H. Hellekson** who has been transferred to Wilmington as assistant director of operations of the department.

Dennis L. Molnar has been named assistant plant manager at Franklin; **Winford J. Janes, Jr.**, plant engineer; and **John B. Moniz**, chief chemist.


TRIANGLE BRAND
COPPER SULPHATE
the Superior Reagent for "Sweetening"
Sweetening in oil refining and processing demands a superior reagent either in the dry form or in aqueous solutions. Triangle Brand Copper Sulphate is versatile and is effective in partly desulphurizing oil, or removing mercaptans, other sulphur compounds, malodorous and resinous substances from cracked distillates.
Triangle Brand Copper Sulphate, 99% pure, will be your reagent of choice once you use it!
PHELPS DODGE REFINING CORPORATION
NICHOLS
TRIANGLE BRAND
CHEMICALS
NEW YORK N.Y.
PHELPS DODGE REFINING CORPORATION
300 Park Avenue, New York 22, N. Y.
5310 West 66th Street, Chicago 38, Ill.

Dravo Corporation has named **John D. Purdy** a Chicago district sales engineer. In his new assignment, Purdy will specialize in the sale of fabricated piping and construction services and grating and stair treads. He has been engaged in specialized equipment sales and engineering work since 1938. For the past six years he has been associated with the George B. Limbert Company, Chicago, handling the sale of piping and allied equipment in the Chicago area.

General Electric Company has named **S. S. Price** and **A. H. Adams** to two newly established engineering posts in the Distribution Assemblies department. Price has been appointed manager of panelboard and motor control design engineering. Adams has been made manager of switchboard and distribution center design engineering.

In his new assignment, Mr. Price will be responsible for all product design activities connected with the department's line of panelboards and motor control centers. He joined the company in 1953 and was formerly cost reduction specialist for the department.

Adams will be responsible for product design activities connected with the department's line of switchboards and sectional type unit substations. He has been with General Electric since 1945. Prior to joining the Distribution Assemblies department, he was a product engineer specializing in industrial control equipment at Schenectady, N. Y.

The Yale & Towne Manufacturing Company has appointed new general managers to direct the operations of its two major domestic materials-handling divisions.

John A. Baldinger of Hinsdale, Ill., who has been serving since 1951 as general manager of the Automatic Transportation Company Division of Yale & Towne in Chicago, has been appointed general manager of the Yale Materials Handling Division in Philadelphia, succeeding **Elmer F. Twyman**, vice president, who had acted also as general manager and who will now make his headquarters at the corporate executive offices in New York.

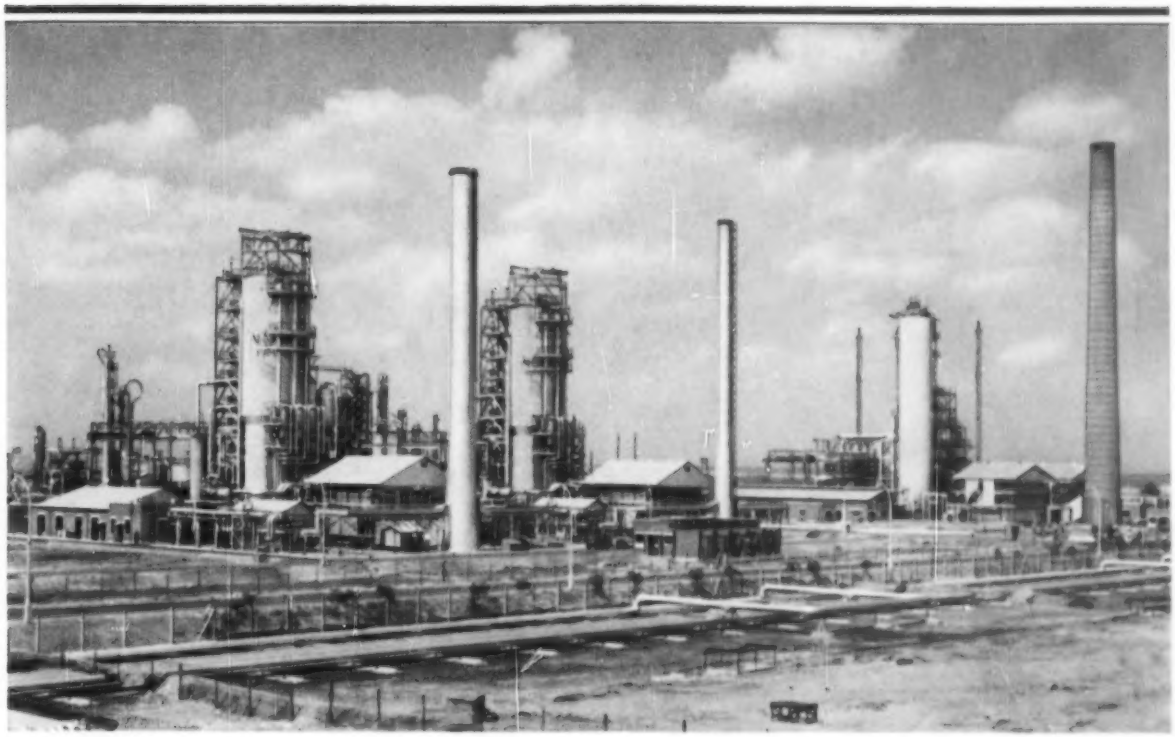
Roy L. Wolter of Chicago has been appointed general manager of the Automatic Transportation Company Division at Chicago. Wolter returns to the Automatic Division which he had served as general sales manager for 13 years and in various other executive, manufacturing and engineering capacities during the three decades he was associated with this division. He was transferred in 1948 to be midwest regional sales manager of Yale industrial trucks.

Atlas Powder Company has cleared **A. H. Cunningham**, sales agent at Los Angeles since 1943 and a member of the Los Angeles explosives sales force since 1918, for retirement.

Cunningham joined Atlas in 1915. The following year he was transferred to the Butte, Montana, office. In 1918, he was assigned to the company's San Francisco Sales District, working from the Los Angeles office as a salesman. He was appointed sales agent there in 1943.

Dow Corning Corporation has elected **Olin D. Blessing**, its sales manager, a vice president. When Dow Corning began business in 1943, Blessing was its first full-time employee. At that time, he had a two man sales department. The present sales organization includes six product group sales managers with headquarters in Mid-

For more data on advertised products, use Readers' Service Cards, last page.



Crude oil from the Middle East is brought to Kent in modern supertankers of 30,000-ton capacity. The Refinery, a portion of which is shown above, is designed to handle 4,000,000 tons of crude per year.

CRUDE OIL COMES TO KENT

The new Kent Refinery of The British Petroleum Company Limited on the Isle of Grain in the Thames Estuary below London, is a substantial addition to England's refining capacity.

The refinery, one of Europe's largest, will supply the British Isles and its export markets with high grade motor fuel, kerosene, fuel oil and lubricants.

Its products and processes were determined by The British Petroleum Company Limited who retained E. B. Badger & Sons Limited, an affiliate of Stone & Webster Engineering Corporation, for the design of certain process units and the over-all planning and erection management of the complete refinery.

Write or call us for information as to how our experience may be of assistance to you.

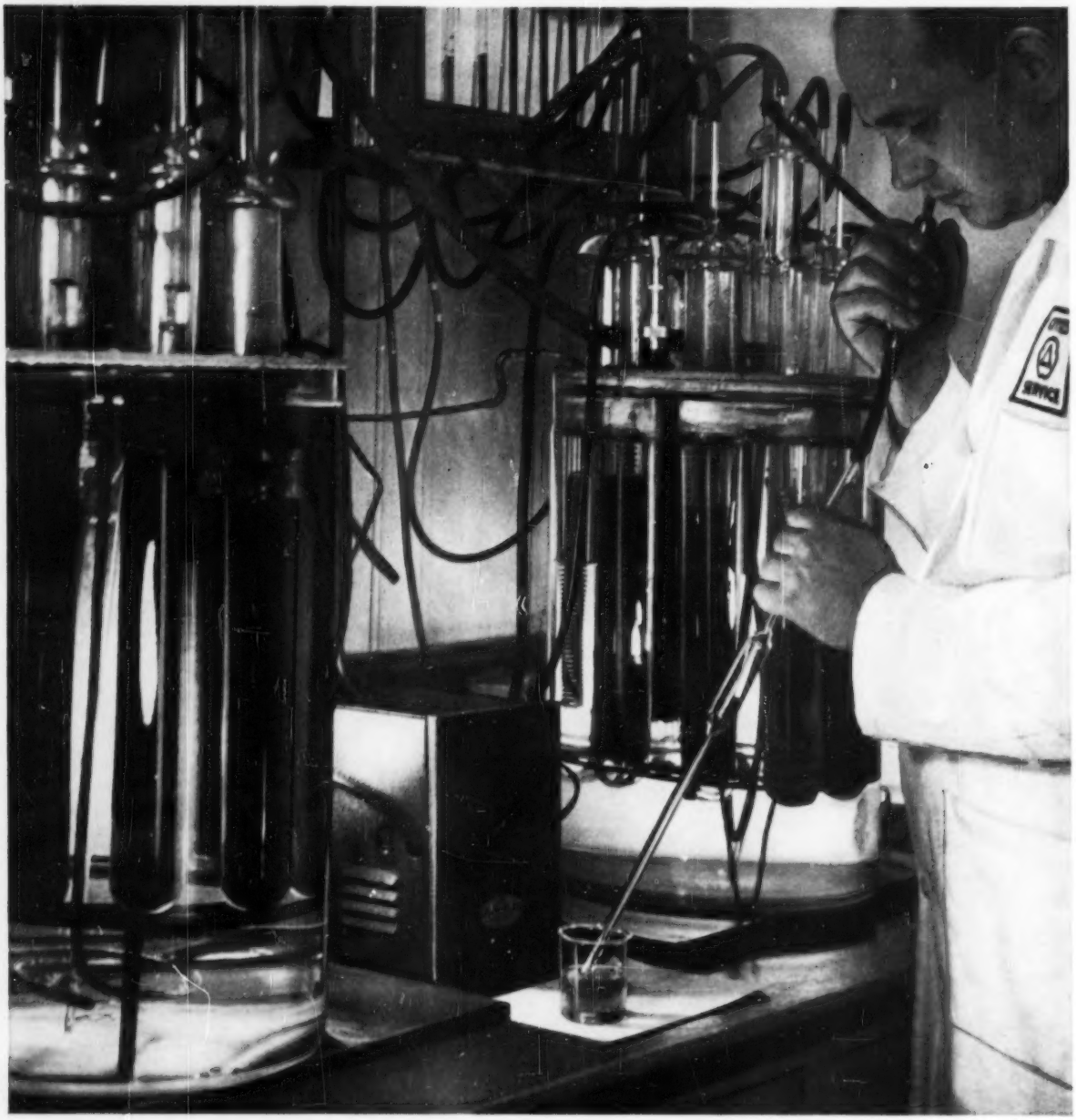
STONE & WEBSTER ENGINEERING CORPORATION

BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

GOING PLACES *into a drop of oil with Cities Service...*



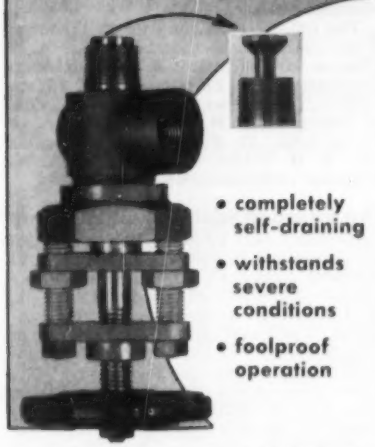
Cities Service researchers enter the minute world of the molecule and come out with new and better products . . . for example, 5-D Premium gasolene and 5-D Koolmotor oil. The superior performance of these new products has boosted sales of Cities Service gasolenes at double the rate of industry demand.

CITIES SERVICE

A Growth Company

Number 15 of a series

New!
Jerguson Drain or Sampling Valve



- completely self-draining
- withstands severe conditions
- foolproof operation

The new Jerguson No. 23 Drain or Sampling Valve is completely self draining, for the valve stem seats on the outside of the valve body. It is ideal for installations where it is desirable to have the valve seat inside the wall of a vessel in order to prevent the typical condition of liquid remaining in the nipple and valve inlet.

This rugged, new Jerguson Valve has outside screw and yoke construction to meet high temperature or corrosive conditions where inside threads cannot be tolerated. The efficient outside thread design eliminates possible freezing and allows the valve stem to work freely at all times. The No. 23 Valve provides foolproof operation because the stem is constructed with a left-hand thread, thus allowing the valve handle to operate in the normal direction of standard valves.

The No. 23 is recommended for pressures up to 4000 lbs. @ 100° F. or 1000 lbs. @ 750° F. Standard with ¾" N.P.T. Male inlet and ¾" N.P.T. Female outlet. Optional features include construction with an additional connection for such uses as a steaming out line, or with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

Write for data unit and complete details.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
Jerguson Trees Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

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land, and eight branch office managers responsible for sales in the areas served by New York, Chicago, Cleveland, Los Angeles, Detroit, Dallas, Atlanta, and Washington, D. C.

Westinghouse Electric Corporation has formed a new department in Baltimore for the manufacture of a line of industrial electronics products. **Robert C. Cheek**, formerly assistant manager of the company's Baltimore Electronics division, has been named manager of the Industrial Electronics department. The department will be part of the industrial heating division which has its headquarters in Meadville, Pa.

The department will be responsible for the engineering, manufacture and sale of induction heating equipment, power line carrier equipment and a variety of other industrial electronic devices.

Cheek joined the Westinghouse student training course in 1939. From 1942 until 1951, he was a consultant on power systems problems and subsequently acted as a specialist in carrier and microwave applications all over the country. In 1951, Mr. Cheek was transferred to Baltimore as assistant sales manager for the electronics division. He was appointed assistant division engineering manager in 1953.

The Dow Chemical Company has elevated its New Orleans office to full sales office rank and **Robert J. Minbiole**, a sales executive, has been appointed as manager.

The office has operated as a branch of the company's St. Louis office. It will continue to service growing markets in an area including Louisiana, the southern half of Mississippi, southwestern Alabama and northwestern Florida.

Minbiole, who joined Dow in 1940, has served since 1944 as manager of film and sheeting sales for the company's Plastics department.

Burgess-Manning Company has opened a New York district sales office at 11 West 42nd Street, New York City, with **W. A. Carroll, Jr.**, as district manager, assisted by **R. T. Oliver** as sales engineer. The company maintains divisions at Libertyville, Ill., Chicago, Dallas, Tex., and Philadelphia.

The Cooper-Bessemer Corporation has elected **Robert F. Lay** as vice president and general sales manager. First associated with the concern in 1924, Lay later joined Baldwin Locomotive Company to become its assistant sales manager. He later served Elliott Company as sales engineer, ultimately becoming chief engineer of the Supercharging division and then production manager.

He returned to Cooper-Bessemer in 1946, serving as head of the Applications Engineering section and later chief engineer in the Products division. After serving as assistant sales manager, he became sales manager earlier this year. This post he held until his elevation to vice president.

Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation has made several changes in its sales organization.

D. R. Beasley was transferred from the plant at Institute, W. Va., to the Fine Chemicals sales group to work on the market development. Mrs. Mary Anna Breanahan joined that group to work on industry

NEW... DELTA COLOR CODE

SAVES YOU: VALVES TIME LUBRICANT ERRORS

The Delta Color Code has been tried and proved foolproof . . . virtually impossible to lubricate your plug valves with incorrect lubricant. Identify each plug valve service by attaching colored tab to Delta Lubricating Fitting, fit colored grip on handle of DELTA Gun, then fill gun with the proper colored Desco Lubricant. Each lubricant is colored to match service.

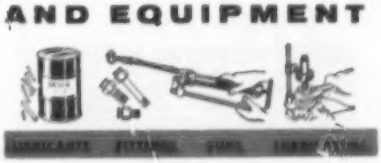
There is no charge for the DELTA COLOR CODE when you use Desco Lubricants. Write for further information.

AMBER	GREEN	RED	BLACK
General Hydrocarbon Services	L.P.G. Services	Acid Services	Hi Temperature Services

The Only Complete Plug Valve Lubrication Company

DELTA ENGINEERING SALES CO.
539 Aero Drive **Shreveport, La.**
Sales Offices in All Principal Cities

DELTA-DESCO
PLUG VALVE LUBRICANTS AND EQUIPMENT



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the NEW USG

SUPERGAUGE®

...built to last a lifetime!

With proper application, the new USG Supergauge will last a lifetime!

SEGMENT—stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

MONO-UNIT CONSTRUCTION—permits easy removal of complete gauge assembly for inspection and adjustment.

ARC-LOC MOVEMENT—permits all calibration adjustments of gauge assembly from rear without removing dial and pointer.

LEGEND ON DIAL—gives complete description of socket, Bourdon tube and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

These features are also available in USG Solfrunt Gauges with solid front construction.

Supergauges available in 4½", 6", and 8½" sizes. For complete information on case styles, materials of construction and connections write for Publication 1819.

UNITED STATES GAUGE USG

Gauge Headquarters FOR OVER 50 YEARS

United States Gauge, Division of American Machine & Metals, Inc., 104 Clymer Avenue, Sellersville, Pa.

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studies and to assist with various market development programs.

J. D. Mueller, after training for Plant Research, will be assigned to the sales group. Arvid Teleki has joined the Market Research department to work on industrial economic research.

The following assignments of Technical Representatives also have been made: **A. P. Chavent**, to Cincinnati; **A. A. Douglas**, to Charlotte; **W. P. Emerson**, to the Atlanta District, **J. F. Flynn**, to Boston; **J. T. Fox**, to New Orleans; **R. F. Gildehaus, Jr.**, to Philadelphia; **D. P. Shannon**, to Kansas City; **B. H. Wilder**, to Detroit, and **R. W. Wittmus**, to Indianapolis.

The International Nickel Company has added **Edward P. Sadowski** to the Development and Research division, as a research metallurgist in the Iron Alloys section of the research laboratory at Bayonne, N. J. The Iron Alloys section is being enlarged to expand research in the field of high temperature alloys for such applications as gas turbines and jet engines.

Sadowski joined the M. W. Kellogg Company in 1950, becoming staff metallurgist. Prior to his association with International Nickel he served for two years on the staff of the Eastern research laboratory of Crucible Steel Company of America, supervising all elevated temperature testing and working on the development of new alloys with emphasis on alloys for use at elevated temperatures.

The Timken Roller Bearing Company has made **Daniel J. Girardi** metallurgical engineer in charge of research and process control. Girardi will direct metallurgical research and mill metallurgical work for all divisions of the company.

Girardi was granted a PhD degree in metallurgy at the University of Michigan in 1941. After a brief career as a teacher at the University of Wisconsin, he became chief metallurgist of the Garfield division of Houdaille Corporation which, during World War II, had been assigned a part in the Manhattan project.

Starting with The Timken Roller Bearing Company in 1946 as a research metallurgist, he became a research metallurgical engineer in 1952, a post which he held until his recent promotion.

Kaiser Steel Corporation has appointed **Jack J. Carlson** as vice president and general manager of the Montebello, Calif., Fabricating division plant. **B. J. Osborne**, present general manager of the plant, will move to the Oakland home offices of the company as assistant to the vice president and general manager for consultation in connection with Kaiser Steel's Fabricating division operations.

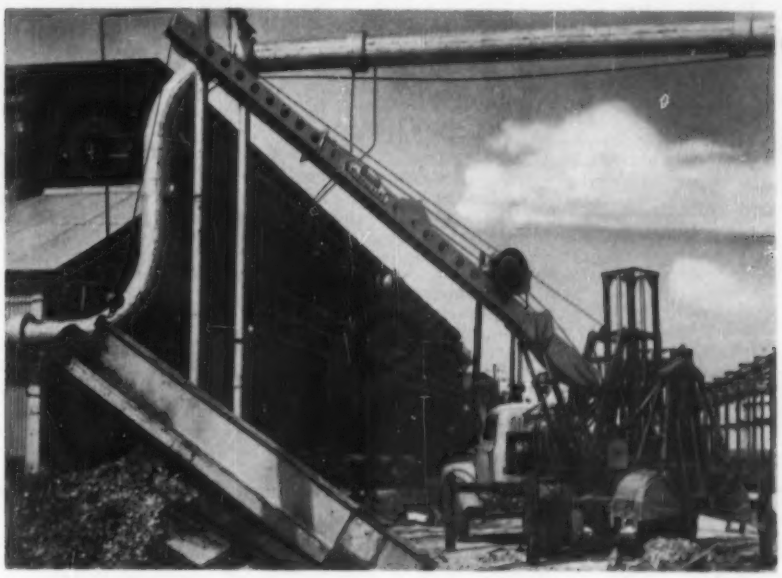
Carlson joined Kaiser Steel in 1944 as administrative assistant. He was successively district sales manager for the Kaiser Steel's offices in Seattle and Los Angeles, and was later appointed assistant general sales manager in the Oakland home office. In 1951 he was named general sales manager, and in 1954 became assistant to the vice president and general manager.

Rockwell Manufacturing Company has promoted **Earl W. Gettens** and **Merle M. Light** to key accounting positions. Gettens, supervisor of hearquarters accounting, has been named supervisor of accounting and budgets, and Light, assistant super-

75 YEARS OF BUCYRUS-ERIE LEADERSHIP . . .

December 18 marks Bucyrus-Erie's 75th Anniversary. In the years since 1880, the company has been proud to bring many significant advancements to the design of excavators . . . the first electric excavator . . . the first crawler-mounted dragline . . . the first all-hydraulic, truck-mounted Hydrocrane . . . and too many more "firsts" to detail here. Most important, however, the know-how back of these is yours in whatever Bucyrus-Erie machine you use.

President Theodore Roosevelt Visits Panama Canal: This Bucyrus-Erie shovel, one of 77 used on the Big Ditch, was included in his 1908 inspection tour.



The precision control of the all-hydraulic Hydrocrane makes it an ideal machine for construction and erection work in refineries.

. . . GIVES YOU TOP PERFORMANCE TODAY . . .

You can expect top performance from a Bucyrus-Erie Hydrocrane because it offers a combination of advantages found in no other machine. There is high speed mobility for moves around storage areas; true precision control with a unique telescoping boom that lets *this crane* work in cramped quarters and hard-to-get-at places. Hydraulically-set outriggers level it on roughest ground, provide a solid working base for fast material handling jobs. Every day, hundreds of users find that these advantages save them time and costs on a wide variety of work.

. . . PROMISES EVEN BETTER EXCAVATORS TOMORROW

You can expect even higher performance standards from Bucyrus-Erie excavators in years to come. The development of new and improved designs, and the search for better materials and more efficient manufacturing methods never ends. With facilities unsurpassed in the industry, Bucyrus-Erie promises you excavators that will serve you better than ever. 46Y55

BUCYRUS-ERIE COMPANY South Milwaukee, Wis.

75 Years of Service

to Men Who Shape the Earth

BUCYRUS ERIE

1880 • 1955

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Suppliers . . .

visor of headquarters accounting, has been made supervisor.

Gettens joined Rockwell in 1946, became assistant supervisor of headquarters accounting a year later and supervisor in 1953. His earlier experience included more than 10 years of auditing and accounting. Light joined Rockwell in 1950 after seven years as a senior accountant with Pressed Steel Car Company, Inc.

Dibert, Bancroft and Ross Company has appointed **G. H. Draper** as its sales representative in Texas. Draper, who will headquarter in Houston, has served as a sales engineer in the Texas-Louisiana-Oklahoma area for a number of years. The company is a New Orleans firm, specializing in foundry and machine work. This line will supplement manufacturers already represented by Draper.

Draper

Diamond Alkali Company has created the position of research scientist within its research organization and promoted **Alfred Hirsch** to the new post. Senior group leader at the Diamond Research Center since August 1954, Dr. Hirsch is a 27-year career man with the company, having joined it as a chemist in 1928. He was named a group leader in 1943.

The Girdler Company has made a number of organizational changes in its Gas Processes Division. Girdler is a division of National Cylinder Gas Company.

R. M. Reed has become technical advisor to the executive vice president. He formerly was head of the Technical department.

C. J. Randolph has been appointed assistant chief engineer in charge of the Process section, and F. A. Hilinski has been appointed assistant chief engineer in charge of the Project section.

The new Process section, supervised by Randolph, is divided into three groups. They are the Process Design group, headed by **J. M. Jackson**; the Operating group, headed by **C. C. Brewer**, and the Process Development group, headed by **Norman C. Updegraff**.

Worthington Corporation has advanced **William C. Osborne** to manager of engineering, Harrison division, and made **Everett C. Schmachtenberg** assistant to the manager of engineering.

Osborne joined Worthington in 1941 as an engineering student. He was assigned by the company to do research work in the California Institute of Technology Hydrodynamics Laboratory from 1948-1950. Since 1950 he has served as product engineer and was promoted to manager of the Research and Development division in 1952. He recently served as assistant to the manager of engineering.

Schmachtenberg joined Worthington in 1937 and has served as test engineer, design and application engineer for pumps and compressors, assistant chief engineer, and most recently as chief engineer of the company's Compressor Engineering department.

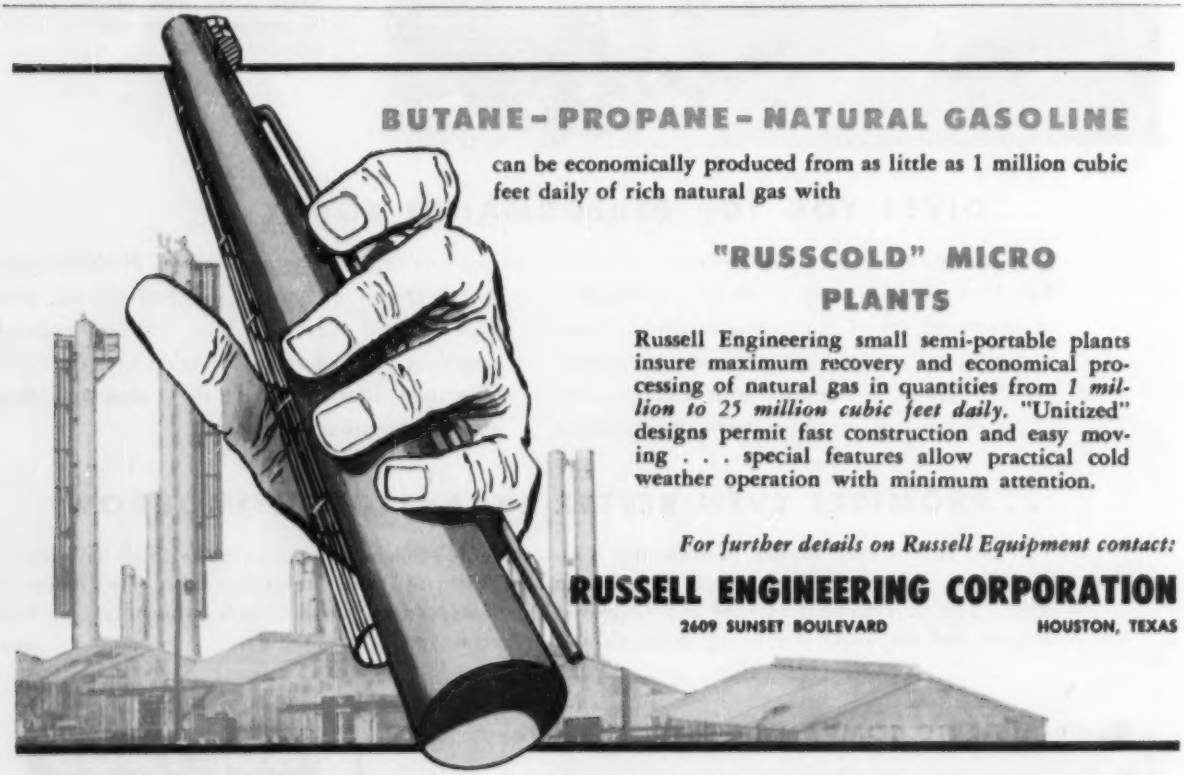
The Dow Chemical Company has named **W. K. Nelson**, who since 1952 has headed the sale of Saran Wrap sales, to broaden his activities, assuming overall responsibility for the sale of commercial applications for all Dow plastic films. At the same time, the company advanced **L. E. Fake**, who has been assigned to Nelson's staff, to take active charge of sales in connection with commercial uses of plastic films.

Nelson, with Dow since 1936, has been engaged in sales work since 1937 except for two years' service as manager of technical service and development for Dow's Western division, San Francisco. Fake came to the company in 1946, serving the past eight years as assistant to **Robert J. Minbiole**, who headed the sale of Saran Wrap and other plastic films for commercial uses until his recent appointment as manager of the company's New Orleans office.

The Emil Greiner Company has established sales agencies and distributors in England, France, Italy and Holland.

Union Carbide and Carbon Corporation has elected **Birny Mason, Jr.**, as secretary. He had been assistant secretary and assistant treasurer of the corporation since 1954.

Mason joined Union Carbide in 1932. He started in the Research department at the South Charleston, W. Va., plant of Carbide and Carbon Chemicals Company, and subsequently held various positions in research, production, and industrial relations with the chemical company. In 1950, he was transferred to the corporation's general offices in New York as executive


BUTANE - PROPANE - NATURAL GASOLINE
can be economically produced from as little as 1 million cubic feet daily of rich natural gas with
"RUSSCOLD" MICRO PLANTS
Russell Engineering small semi-portable plants insure maximum recovery and economical processing of natural gas in quantities from 1 million to 25 million cubic feet daily. "Unitized" designs permit fast construction and easy moving . . . special features allow practical cold weather operation with minimum attention.
For further details on Russell Equipment contact:
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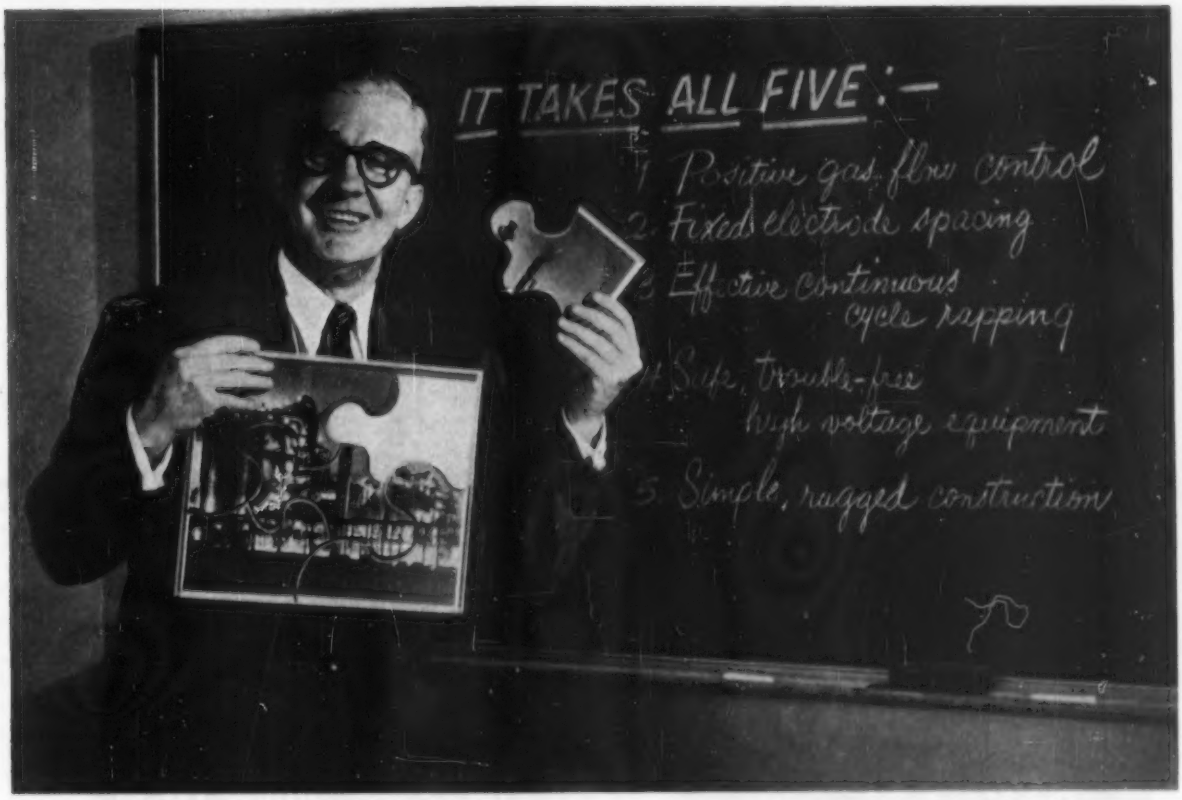
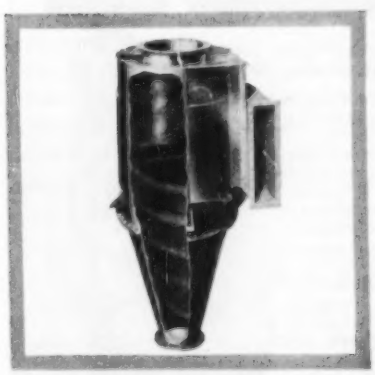
"DESIGNERS AND BUILDERS OF SPECIALIZED GAS PROCESSING EQUIPMENT"

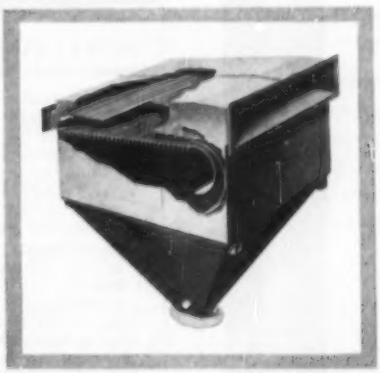
Buell 'SF' Electric Precipitators meet all 5 basic requirements for TOP EFFICIENCY


IT TAKES ALL FIVE :—
1 Positive gas flow control
2 Fixed electrode spacing
3 Effective continuous cycle rapping
4 Safe, trouble-free high voltage equipment
5 Simple, rugged construction

A slight deficiency of any single factor would be sufficient to impair the performance or service life of any dust recovery system. The constant top efficiency of Buell installations is the result of skillfully adjusting all five elements to best meet various operating conditions . . . provide consistent top efficiency.



Buell Cyclone Collectors are noted for their efficiency, too. Here are exclusive reasons why: shave-off design which harnesses back-flow and puts it to work . . . plus extra large diameter design to prevent "plugging."



Buell "LR" Fly Ash Collectors are ideal for low and high pressure boiler operations up to 2000 BHP, with either natural or mechanical draft. Check them for high efficiency, simple design, compactness, flexibility in layout.

FREE BOOKLET!
"The Collection and Recovery of Industrial Dusts"
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New York 5, New York

buell®

MECHANICAL ELECTRICAL *Experts at delivering Extra Efficiency in* **DUST COLLECTION SYSTEMS**

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ENGINEERS

Chemical, Mechanical or Oil Refining

Company has several openings for engineers, with 2 to 8 years experience in design and or operation of processing equipment, for process design position leading to sales.

Salary, bonus and excellent working conditions.

Box 40-R
c/o Petroleum Refiner
Houston, Texas

Suppliers . . .

assistant to the vice president in charge of industrial relations. Two years later, he became manager of industrial relations for the corporation, a position that he held until 1954.

U. S. Steel Corporation has appointed Milton A. Grappe as store manager at Pampa, Texas, for its Oil Well Supply Division. Grappe started with Oilwell in 1947 at Borger, and in 1950 was transferred to Pampa. In 1951, he became field representative at Albany, Texas, and three years later was returned to Borger as field representative, a position he held when he was named to his present post in Pampa.

Diamond Alkali Company has named **Kurt Albrecht** to the Detergent Section of its Silicate, Detergent, Calcium Division as a research chemist. Albrecht previously was with Calgon, Inc., a division of Hagan Corporation, Pittsburgh. He had been a chemist and group leader in detergent research for the past 18 years. In his new post, Albrecht will be concerned principally with development of new detergent formulations, direction of technical service work on metal-cleaning applications of Diamond chemicals, and improvement of analytical techniques.

Borg-Warner Corporation has appointed **H. Charles Yaeger** as manager of manufacturing at the Pesco Products division in Bedford, Ohio. He previously was factory manager of Jacobs Aircraft Engine Company in Pottstown, Pa., for three years. He also served with Wright Aero Corporation at Patterson, N. J., for six years.

Texas Alloy Products Company has added **Warren Carhart** to its staff. He will serve as sales manager. Carhart formerly was vice president and sales manager for Western Gear Company, Los Angeles. Prior to joining the Texas Alloy organization, he had served as general manager of Southwestern Gear division at Houston.

General Electric Company has appointed **William W. Bryan** as manager of its Construction Materials Pacific district. He succeeds **Daniel F. Flinn, II**, who has resigned.

Bryan has been with the General Electric Company since 1934. Previous to his present appointment, Mr. Bryan was manager of the division's Northwestern district, a position he will continue to fill temporarily, in addition to his new duties.

The Dow Chemical Company has located its area sales office in the new Fulton National Bank Building in Atlanta. The office, founded in 1950, services markets in Georgia, Alabama, Florida, North Carolina and South Carolina. Its manager is **Leroy C. Stewart**, a veteran of 37 years with the company.

The International Nickel Company, Inc., has named **Lester E. Jones** as supervisor of the Industrial Chemicals section of its Development and Research division in New York. He will concentrate on developments in nickel catalysts and nickel compounds.

Before joining International Nickel, he served as sales manager for Genesee Research Corporation, an Olin-Mathieson Chemical Corporation subsidiary, and in

NEW TYPE II VISCOMETER

Portable or Panel Mounted
TO INDICATE KINEMATIC VISCOSITY

The Type II Viscometer, a new and completely different type of laboratory-field instrument, is the first of its kind ever developed for directly determining *in a matter of minutes* the kinematic viscosity of fuels, oils, weak acids, and other base solutions.

Range of the Type II, which employs a new method based on a flow system of advanced design, is .5 to 5.0 centistokes. This range includes all liquids used in testing aircraft fuel system components. Readability of the instrument is well within 1% of the indicated viscosity at any point on the scale.

- Use it in the laboratory, field, or on new or existing equipment.
- Widest range. Outstanding readability.
- Simple to operate. Readings obtainable in a few minutes.
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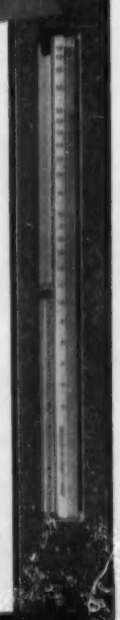

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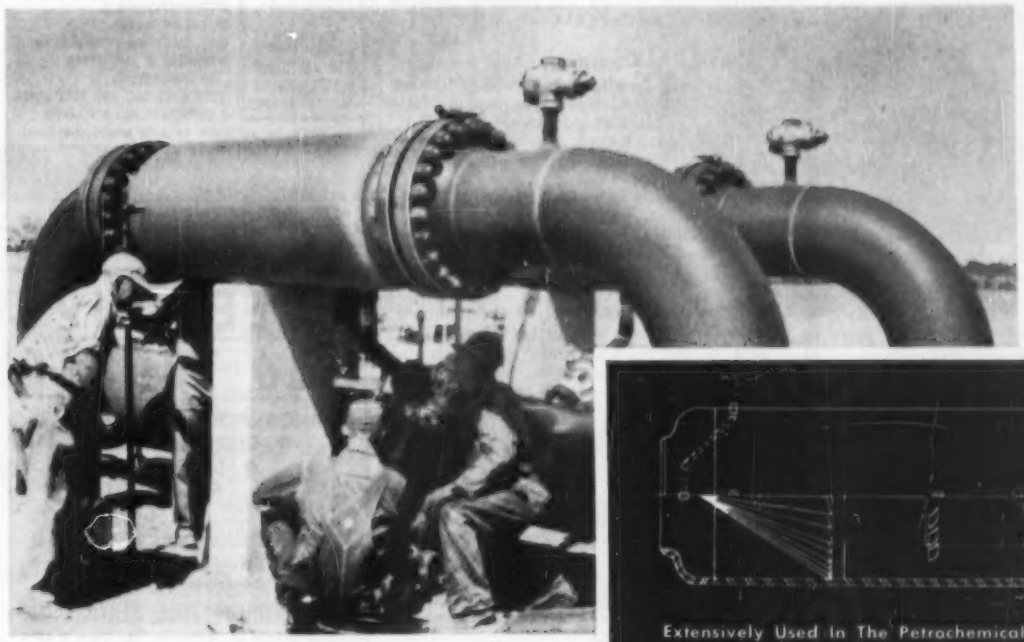
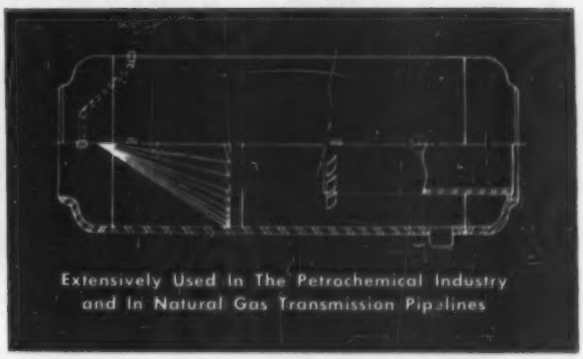


Photograph of actual installation of a Centrifix 16 inch 1000 PSIG SRW Line Purifier with spray connection and 20 inch inlet and outlet. The overall length is 6 feet 6 inches.



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Suppliers . . .

other sales positions with the parent company. He also has been associated with U. S. Industrial Chemicals, Inc., E. I. du Pont de Nemours & Company, National Aniline Division of Allied Chemical & Dye Corporation and Emery Industries, Inc.

Clark Brothers Company, one of the Dresser Industries, has named **E. G. Hotze** to succeed **F. H. Hayes** as manager of its Houston district. Hayes, with the company since 1935, has retired.

Hotze joined Clark Brothers in 1942 as a sales engineer and had been assistant manager in Houston since 1952. Before taking a place with the company he was with Cities Service Oil Company.

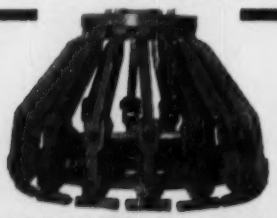
Walworth Company has appointed **George W. Newland** as central division sales manager, with headquarters in Pittsburgh, Pa. He succeeds Joseph E. Mihm, who has been named assistant vice president of Walworth, with headquarters on the West Coast.

Newland has been with Walworth Company for the last eight years, previously having held the position as head of the Order and Sales department of the Pittsburgh Forgings Company.

ACF Industries, Inc., has appointed **James C. Stowers** as assistant to the president of the Nuclear Energy Products division of ACF Industries, Inc. Stowers, who was manager of the Kansas City, Mo., field office of the Atomic Energy Commission, was awarded the Legion of Merit for his activity in connection with the Oak Ridge, Tenn., Atomic Energy Project during World War II.

The company has also named **Harold Etherington** and **William Jackel** as vice presidents of The Nuclear Energy Products division. Jackel is manager of the company's operations at Albuquerque, N. M., while Mr. Etherington will be located in the New York offices of the company.

(More Suppliers Notes 317)



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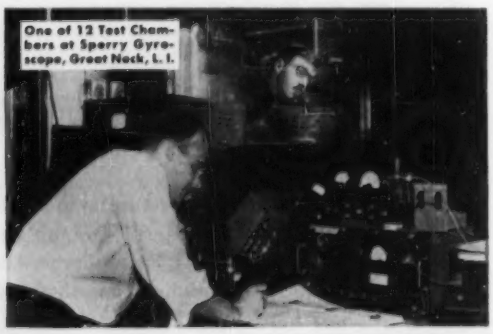

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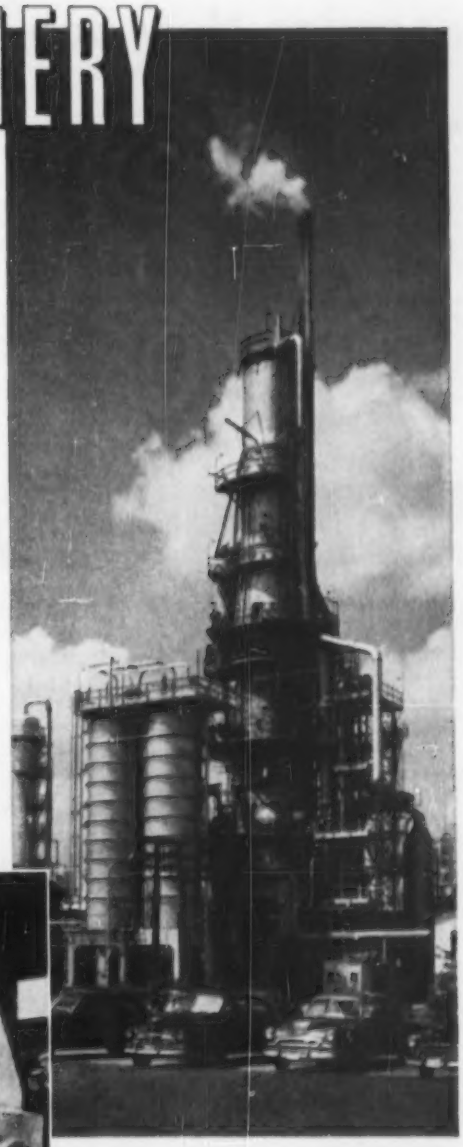
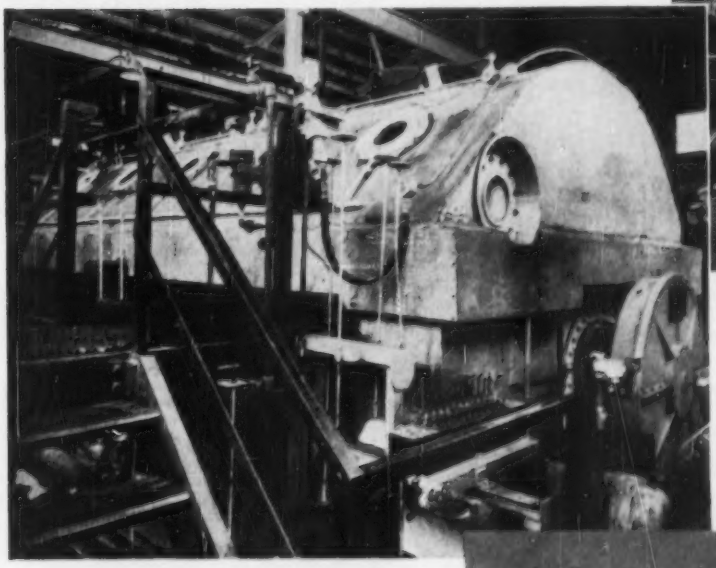


FLUID CAT CRACKER

CB&I built the reactor-regenerator and catalyst hoppers for the UOP fluid catalyst cracking unit shown above at the Rock Island Refinery Corp., Zionsville, Indiana, refinery.



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For more data on advertised products, use Readers' Service Cards, last page.

Reviewing New Books . . .

Manual on Refinery Wastes, supplement 2 to Volume II on Waste Gases and Particulate Matter of the API Manual on Disposal of Refinery Wastes. This new supplement deals with Air-Pollution Surveys.

It provides data on the amounts of pollutants coming from refineries and from nearby sources; the distribution of polluting materials in surrounding areas under varying meteorological conditions, and the physical, chemical, and biological effects of various concentrations of polluting materials at specific points. The book points out that measurements of polluting materials should be preceded by qualitative evaluation of process units, storage tanks, maintenance operations, flares, and burning pots and stacks as sources of pollutants. Odor evaluation is a valuable method for locating troublesome sources of pollution, particularly where the pollution occurs in low concentrations.

Quantitative evaluations may involve: (1) material-balance analyses for estimating total quantities of pollutants released from a refining unit; (2) air sampling, usually with continuous recorders or scrubbers, at various locations inside or beyond refinery boundaries; (3) chemical analyses and/or physical studies of samples; (4) evaluation of measured concentrations in relation to established maximum allowable concentrations; and (5) control determinations of the effect of refinery emissions on plant life.

(American Petroleum Institute, 50 West 50th Street, New York 20, available without charge to holders of the Fourth Edition of Volume II.)

Physical-Chemical Properties of Ethane-Nitrogen Mixtures, by B. E. Eakin, R. T. Ellington and D. C. Gami. Publication of studies in the physical-chemical properties of binary mixtures of methane, ethane and nitrogen at the Institute of Gas has been completed with the issuance of this research bulletin, numbered as IGT Research Bulletin 26. The methane-nitrogen studies were published in 1952 as Bulletin 17, and the methane-ethane study was completed in 1953 as Bulletin 22.

These three bulletins and their ancillary 18, *Thermodynamic Properties of Nitrogen* (1952) and No. 21, *Thermodynamic Properties of Methane-Nitrogen Mixtures* (1955) collectively provide data essential for the engineering design of plants to separate the pure elements of natural gas.

(Institute of Gas Technology, 17 West 34th Street, Chicago 16, 40 pages, $5.)

Specifications for Flanged and Welding-End Forged and Cast Steel Gate and Plug Valves, prepared by the API Committee on Refinery Equipment of the Division of Refining. This publication, designated as API Standard 600, Third Edition, July, 1955, covers service classification and sizes; general requirements for end flanges and welding ends, and drain and by-pass connections; material, design, and fabrication of gate valves and plug valves; gate and plug valve tests; marking; inspection and rejection; and shipping. Tables are given of Class A and Class B pressure-temperature ratings, plug and gate valve dimensions, test pressures, material specifications, and plug-valve classification.

(American Petroleum Institute, 50 West 50 Street, New York 20, $1.50.)

Industrial Furnaces, Volume II, by W. Trinks. This third edition has been more than half rewritten to incorporate the latest developments in furnace know-how.

Concentrating on fuels, furnace types, and furnace equipment, Volume II of "Industrial Furnaces" delves into all phases of operation as they are known and handled today. It supplies more than fifty new items in this edition, not counting the 117 new illustrations and the entirely new chapter on safety measures.

The volume discusses new burners and furnace types; improved mounting of electric heating elements and practical methods of calculating them; the application of protective atmospheres; information on fuels and electric energy, and labor-saving devices for moving material into, through, and out of furnaces.

New data on tar-pitch; direct resistance heating; up-to-date facts on resistors; recent types of temperature-control instruments; link-belt chains and woven-wire belts; a comparison of fuels and furnaces on six bases, and the effect of local conditions on selection of heating methods also are among the points taken up.

In addition, new charts for carburization and decarburization of steels of various carbon contents are supplied, as well as details on the properties and cost of

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A well-known oil refinery had an injunction to stop operations of its catalytic cracking unit, due to odors emanating from spills, separators and other wastes, stack fumes and products of combustion. RHODIA was consulted and ALAMASK used. Here is an excerpt from a letter from the refinery:

"Very effective masking of odors resulted and in view of our actions all cases against us were withdrawn. We are very grateful to RHODIA for what they have done for us and are happy to pass on our experiences to others in similar difficulty."

If odors from your refinery are contaminating the community, RHODIA can help you, too. Our experienced odor engineers will be happy to consult with you on your malodor problems.

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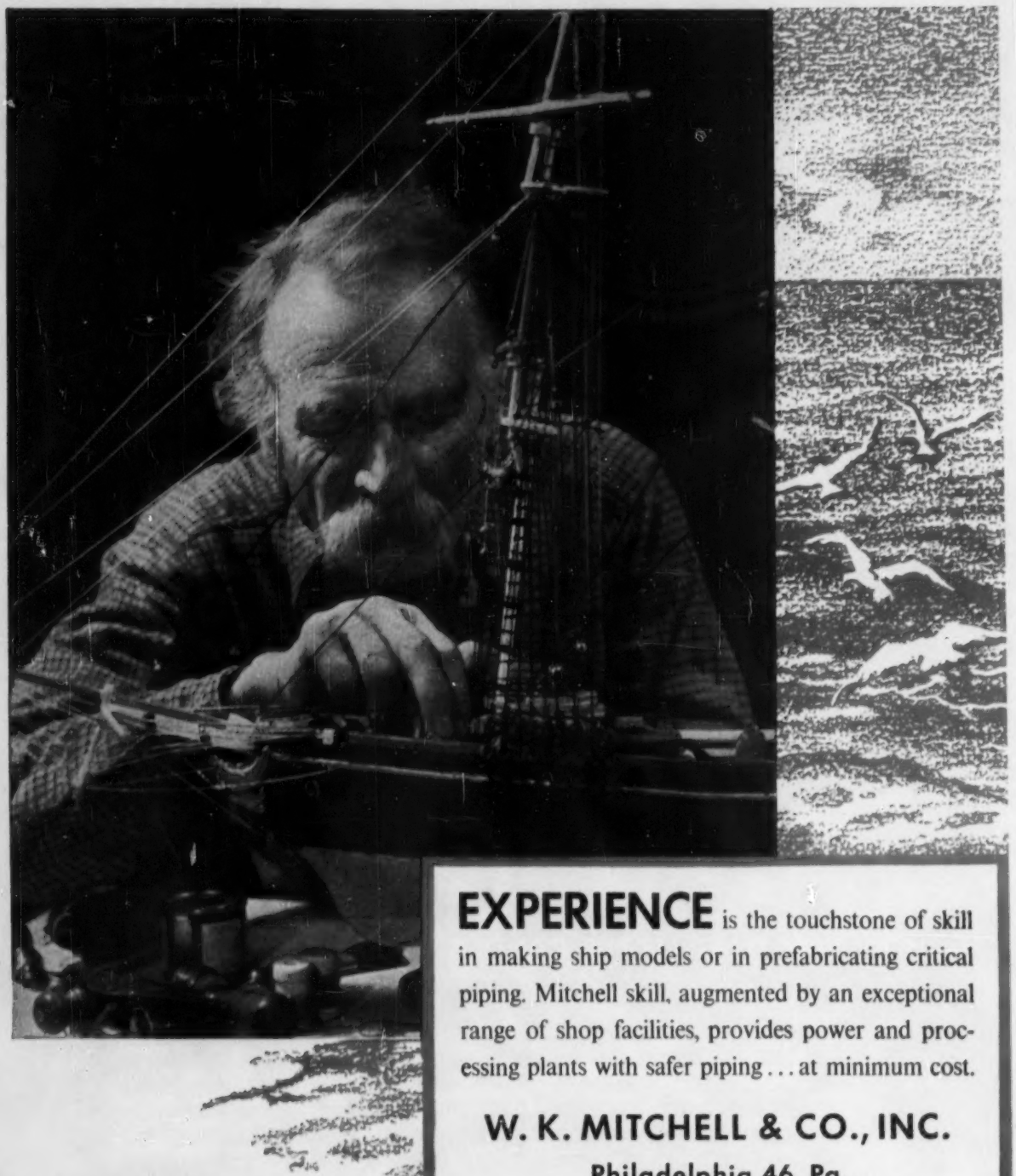

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liquefied petroleum gases; salt baths; charging levers; hearth rollers, and other items of operating value.

The new book is a companion volume to Volume I which deals with principles of furnace design and operation. Both volumes have been translated into several languages.

(John Wilsey & Sons, Inc., 440 Fourth Avenue, New York 16, 358 pages, $10.)

Partially Fluorinated Esters and Ethers as Temperature-Stable Liquids, Part II, Physical and Chemical Properties. This publication describes a new series of partially fluorinated esters and ethers synthesized in experiments at the Naval Research Laboratory. It is concerned with the physical and chemical properties of these compounds and the effects of fluorination on properties of interest in lubrication and hydraulics. Good viscosity and oxidation stability, high boiling points, low flammability and good stability to hydrolysis of some of the compounds indicate their advantageous use as lubricants, hydraulic fluids and plasticizers.

Suggested applications are as lubricants for aircraft gas turbine engines, in silicone-insulated electric motors and generators, in submarines, between decks on shipboard, in heated plants, for baking and drying equipment, and other mechanisms operating at high temperatures.

(Office of Technical Services, U. S. Department of Commerce, Washington 25, 26 pages, 75 cents.)

Ferrous Metals, Part 1, 1955 Book of ASTM Standards. This part, containing 315 standards, is 11-percent larger than the 1952 edition and contains 125 standards that are new or have been revised since the 1954 Supplement. Since 1952, 211 standards are new or revised.

This part contains standard and tentative specifications, methods of test, and definitions for steel piping materials; flat products; bars, bolts, and rivets; billets, forgings, and axles; rails and accessories; railroad wheels; springs; concrete reinforcement; corrosion-resisting steel; metallic coatings for steels; welding rods; wrought iron; cast iron; malleable iron; magnetic materials; ferro alloys; and metal powders; as well as general methods of testing. It is especially important in the heavy machinery, railroad, and construction industries. Materials engineers, purchasing agents and others concerned will need the new Part 1 to enable them to be sure of using the latest applicable standards.

The remaining parts of the 1955 book are expected to be ready for publication in February, 1956.

(American Society for Testing Materials, 1916 Race Avenue, Philadelphia 3, 1834 pages, $13.50. The complete seven-part 1955 Book of Standards will cost $84.)

Improved Methods of Export Packaging Quart Oil Cans, Bureau of Supplies and Accounts, U. S. Navy. This research report indicates that present military specifications (MIL-C-124-B) for packaging 24 round cans of motor oil do not provide sufficient protection for export.

It recommends that present specifications be changed to require packaging in wirebound boxes or Q-crates. The cost of packaging in wirebound boxes would be slightly higher because of the hand-filling that is necessary. Companies using these containers, however, will be furnishing a package equivalent to the Q-crate, at a labor cost equivalent to their past bids.

(Office of Technical Services, Department of Commerce, Washington 25, 57 pages, illustrated, $1.50.)

Petroleum and Natural Gas, a part of the Bureau of Mines' Bulletin 556 *Mineral Facts and Problems,* will be interesting to both laymen and technologists. It includes historical descriptions and significant items about current production, reserves, transportation and the uses of petroleum and natural gas.

One point of interest is that the report shows that contrary to popular impression, a handful of companies do not control the oil and gas industries, but that more than 18,000 firms are engaged in its various activities.

(Superintendent of Documents, Government Printing Office, Washington 25.)

New Books . . .

Instrumentation, Boundary Layer Radioactive Tracer Technique, Part I, prepared by North Carolina State College for Wright Air Development Center. This report of Air Force-sponsored research describes the application of a new technique for the measurement of velocity profiles in flowing fluids.

This technique, based upon displacement of a radioactive or dye solution from the tube, has been used successfully for velocity measurements to within 0.002 inch of the wall of one-half inch diameter tube.

(Office of Technical Services, Department of Commerce, Washington 25, 107 pages, $2.75).

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Please send complete resume including salary requirements, also recent small photo of self if convenient, to:

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Chemist thoroughly versed in the chemistry, treatment and technology of asphalt, to conduct research and development in this field. Attractive position with an expanding and progressive organization interested in this field. Pleasant working conditions in an air-conditioned laboratory. Fringe benefits. Midwest location. Send resume of qualifications, photograph and salary desired. Box 216-R, PETROLEUM REFINER, Houston, Texas.

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Graduate engineers with minimum 5 years' experience in design or inspection of petroleum processing plants and equipment. Major part of experience must have been in inspection work entailing general knowledge of all facilities. Develop inspection methods, supervise and conduct inspections and advise operations on codes and equipment limitations in a major oil installation located in Saudi Arabia.

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General Control Company has named two regional representatives for its Air Conditioning and Refrigeration Controls division. **Jack Croushore** is supervising the division activities of the Chicago regional office, and **Ray Wheeler** has taken charge at the office in Columbus, Ohio.

The Lincoln Electric Company has opened a new branch office and warehouse in Denver, Colo. District manager for the area will be **Merrill F. Yale** who has been a sales engineer in Lincoln's San Francisco office since 1949. **Scotty Lambrecht**, a native of Denver, trained in welding engineering, will assist Yale.

Ray Zeh has been made district manager for The Lincoln Electric Company in Chicago. For the last four years, Zeh has been district manager for Lincoln in Syracuse.

U. S. Steel Supply Division of United States Steel Corporation has opened a new steel warehouse in the Trinity industrial district of Dallas, Texas. **A. R. Schmitt** will be the U. S. Steel Supply Division sales representative in the Dallas warehouse office, and **C. W. Hopkins** will continue to represent the division in northeast Texas. **W. W. Schweitzer** will be the division's salesman in Fort Worth with a territory including northwest Texas.

Suppliers . . .

The Frontier Refining Company has appointed **William R. Seuren** as vice president of sales. Seuren joined Frontier as sales coordinator in January 1955. Prior to that, he spent five years with Deep Rock Oil Corporation as assistant industrial sales manager, lube oil supervisor, and assistant to the vice president of manufacturing.

S. Morgan Smith Company has appointed Moody-Price, Inc., Baton Rouge, La., as representative for its Valve Division in the Louisiana-Southern Mississippi territory. **Jere Price** and **Ray Moody** will represent S. Morgan Smith in this territory.

Atlas Powder Company has completed a $100,000 nitration process laboratory at its explosives experimental laboratory at Reynolds, near Tamaqua, Pa. The new laboratory is a pilot plant installation which will allow studies of nitration reactions in plant-type equipment, but on a smaller scale than is practical in an operating plant.

General Controls Company has named **B. L. Lerch** Midwest regional manager, and his assistant, **Norbert A. Grainer**, has succeeded him as manager of the firm's Chicago branch.

The Girdler Company has made a number of organizational changes in its Gas Processes division. Girdler is a division of the National Cylinder Gas Company.

R. M. Reed has become technical advisor to the executive vice president. He formerly was head of the Technical department.

C. J. Randolph has been appointed assistant chief engineer in charge of the Process section, and **F. A. Hilinski** has been appointed assistant chief engineer in charge of the Project section.

The newly established Process section, supervised by Randolph is divided into three groups. They are the Process Design group, headed by **J. M. Jackson**; the Operating group, headed by **C. C. Brewer**, and the Process Development group, headed by **Norman C. Updegraff.**

Burgess-Manning Company has appointed **Dudley W. Day**, vice president, as general manager of its Penn Instrument division at Philadelphia, and **Allen Wilson** as general manager of the Architectural Products division at Chicago.

The company also maintains divisions at Libertyville, Ill., and Dallas, Tex.

Fisher Governor Company, Marshalltown, Iowa, has moved into its recently completed research and engineering center. The new three-story brick structure has 100,000 square feet of space and is completely air-conditioned. It covers approximately half of a square block and about 200 of Fisher's 1250 employees are assigned to the building.

The enlarged product engineering department is located adjacent to the research laboratory area. Sales Engineering, executive offices and general office departments are also in the new building.

HELP WANTED

Refinery Operations Engineers

California Texas Oil Company has a limited number of positions available for graduate engineers qualified for:

- Economic analysis of proposed refinery expansion programs.
- Planning of organizations and staffing of new refineries.
- Assisting management in reviewing and preparation of investment budgets and operating cost forecasts.
- Coordination of technical and economic research in refinery operations.
- Foreign Service of limited duration if necessary.

Applicants must have at least 5 years' experience in petroleum refinery operations and be suited for supervisory positions.

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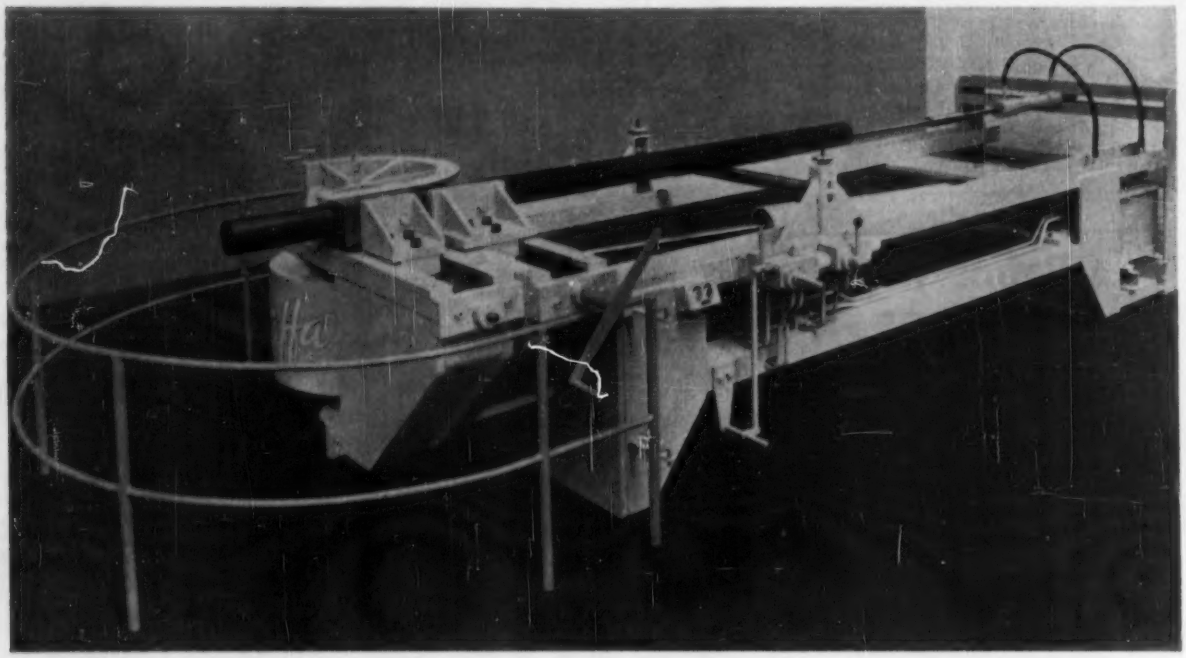
For more data on advertised products, use Readers' Service Cards, last page.

What's New In Equipment . . .



Here's a New Quick Precision Pipe Bender

Hydraulic Pipe Bending Machine . . . Chamberlain Industries, Ltd., has developed a newly designed tube bending machine. Hydraulically operated, the illustrated machine is capable of 180 degrees, close radii bends, in tubes up to 3 inches. Similar models are available for tubes up to 12 inches. The tubes are bent cold and unloaded in approximately 25 seconds. Walter P. Hill, Inc., is associated with Chamberlain Industries in the development of these machines in the U. S. and Canada. For further information . . .

Circle E1 on Postcard

A new plug valve lubricant offering an unusually broad temperature range has been announced by Rockwell Manufacturing Company. The efficient temperature range of the lubricant is 40 degrees below zero to 500 degrees above in the bulk form and 20 degrees below to 500 above in the stick form.

Service conditions under which the lubricant will successfully perform include gasoline, kerosene, fuel and lubricating oils, crude distillate, sweet or sour natural gas and manufactured gas with water or organic condensate, LPG systems, dilute acids and alkalis, glycols, aqueous solutions of other organics. For detailed information . . .

Circle E2 on Postcard

Combination Valve . . . Fluid Mechanics Company, Houston, has designed a valve for low pressure tanks needing both pressure and vacuum relief. It is in effect two separate valves mounted in one valve body.

On the vacuum side the valve can be set to open on as little as one inch of water differential. It can be set to exhaust at ½ pound per square inch to 150 pounds per square inch.

On the pressure side the valve can be modified to relieve in overpressure or to relieve in blowdown control. In the latter case, the pressure inside the tank must fall a set amount below the relief pressure before the valve will reseat.

The combination valve is constructed of high grade cast iron with bronze inner valve parts. The springs which load the two seats are stainless steel and are adjustable over a wide range of pressures. Both sets of seats are microlapped to insure proper seals.

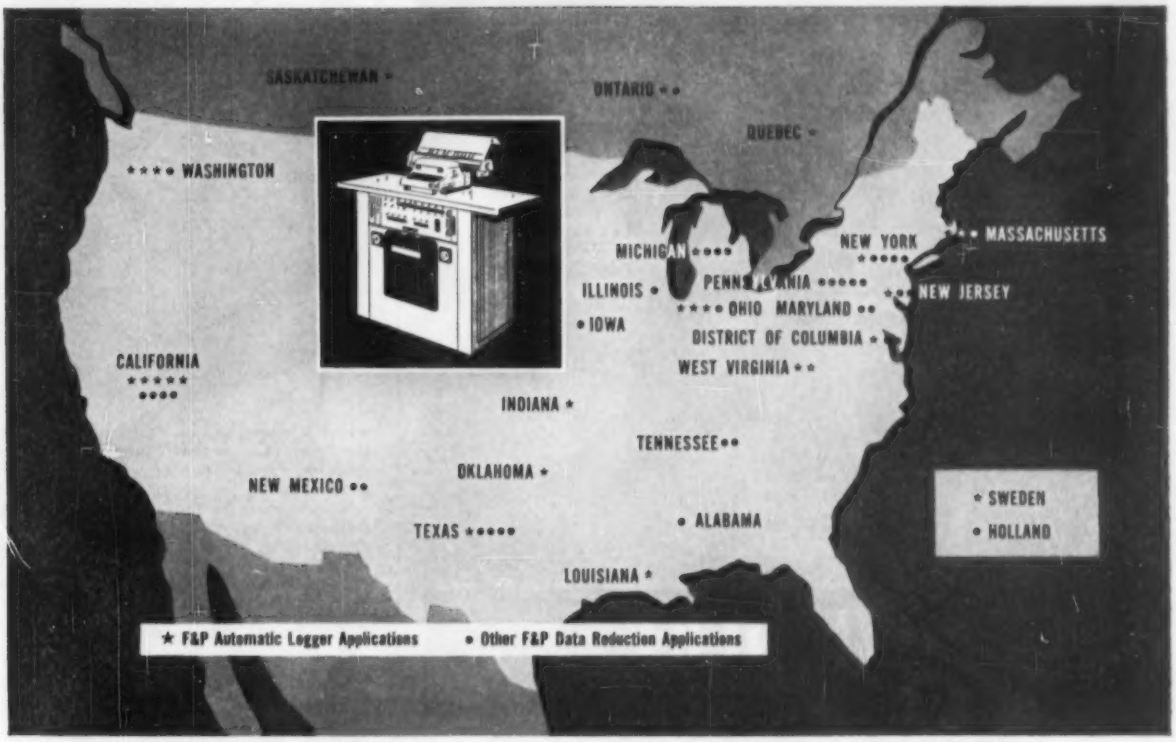
The lift lever operates the pressure seat only. The valve is shrouded with copper screen to protect the working parts from insect damage. Just . . .

Circle E3 on Postcard

Pneumatic Integrator . . . The Foxboro Company has a new model number 14A Pneumatic Integrator which requires no cams for square root extraction. The device provides continuous linear integration of industrial process flows to within ½ percent.

In operation, the integrator receives a 3-15 psi measurement signal from a differential pressure transmitter. This signal, applied through a bellows, positions a force bar in relation to a nozzle. The resulting back pressure at the nozzle, amplified by

F&P complete process instrumentation



F&P Automatic Logger boosts profit and production in many manufacturing and processing industries.

Across the Continent, F&P Automatic Loggers Are Revolutionizing Instrumentation Concepts

New digital approach transforms instrumentation from capital expenditure to revenue producer

A new trend in industrial instrumentation is exemplified by the expanding list of F&P Automatic Logger applications. This has produced a radical adjustment in the thinking of manufacturers as to production and process control systems.

The Automatic Logger—designed and developed by Fischer & Porter—is an automatic high-speed means of converting pneumatic and electrical signals of pressure, temperature, flow and other variables into digital form, such as type-written log, punched tape or card. While logging occurs at preset intervals, the logger continuously samples essential variables and stores information for readout at subsequent periods. Analog computer techniques translate data into useful operating guides that result in increased production and plant efficiency—and provide invaluable data for planning greater future production.

F&P Data Reduction & Automation Systems combine proven instrumentation components with the newest ideas in computer control and digital presentation of data. This has transformed instrumentation from a mere means of measurement and control to a new operating technique which pays off in dollar savings.

For detailed information about the F&P Automatic Logger, what it is doing for others, and its potential usefulness to you, consult the F&P Sales Engineer in your locality. Or write us direct.

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Measuring, recording and controlling instruments
Centralized control systems
Data reduction and automation systems
Chlorination equipment
Industrial glass products

Sales offices in 32 American cities and in principal cities abroad

For more data on advertised products, use Readers' Service Cards, last page.

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. . . and Stationary Fire Tube Boiler Tubes can be rolled and flared in one operation with this Modern Parallel Rolling Tube Expander.
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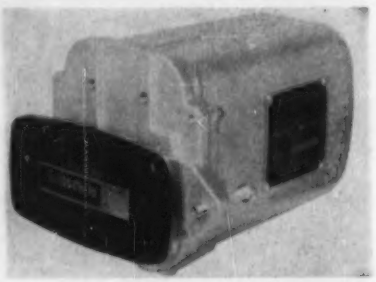
New Equipment . . .

an air relay, regulates a jet of air onto the blades of a turbine wheel.

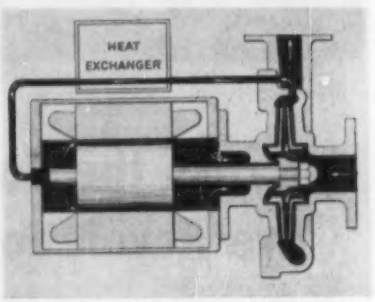
As the wheel revolves, a weight, pivoted on the wheel, produces a centrifugal force. This is fed back to the bar to balance the measurement signal. The revolving turbine



wheel is geared to a counter which totalizes the flow. Thus, a flow change is instantly reflected in a change of wheel speed and a rebalancing of forces. The centrifugal principle extracts the square root factor introduced by the differential pressure measurement so that integration of flow is linear.

For additional information on this new instrumentation device . . .

Circle E4 on Postcard



Seal-less Pump for High Temperatures . . . Chempump Corporation has developed a new "Canned Motor" Pump for High Temperatures which uses an integral heat exchanger with a special high temperature pump design. This makes the canned motor Chempumps ideal for handling Dowtherm, Arochlor, hot fats, hot oils and similar fluids at temperatures as high as 1000 F., depending on the cooling water temperature. Two Chempump model series have the necked down design for high-temperature work. Model CHS pumps are available in 5 and 7½ horsepower sizes and Model CFT units in ¾ and 1½ horsepowers. Maximum head developed is 195 feet and maximum capacity is 250 gpm. For information on high temperature leak-proof Chempumps . . .

Circle E5 on Postcard

High Temperature Insulation . . . A new heat insulation product that withstands temperatures of 1800 F. has been developed by Owens-Illinois Glass Company.

The new hydrous calcium silicate product, used primarily as covering for pipes and vessels, has the unique advantages of

This NEW Handbook
of engineering data on J-M products

. . . provides valuable information to help you solve many design and operating problems

Here is a new handbook which can be a valuable aid to you in many ways in improving operations and lowering maintenance costs in your plant.

Whether your problem is reducing heat loss, fighting corrosion, sealing gases and liquids, controlling motion, filtering liquids, improving formulae or protecting against fire, weather and wear, this handbook will aid you in finding the solution.

This handbook contains 52 pages of useful up-to-date engineering information on Johns-Manville products used in the process industries. The answers to your thermal insulation problems may be found in the section which shows methods of calculating heat transmission. Also included are tables of heat losses from bare surfaces and equivalent thicknesses of pipe insulation. Graphs provide information on surface resistance for both pipes and flat surfaces.

For your copy of this handbook, simply fill out the attached coupon and return it to us.

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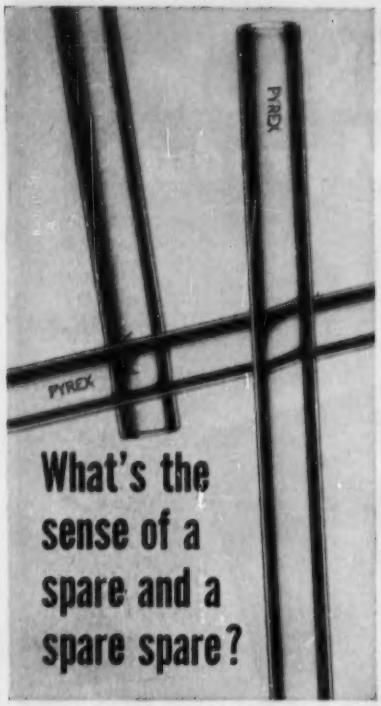

Save money on gauge maintenance. Always keep two gauge glasses "on the bench" for every one in use.

You save time when replacements become necessary, because:

Spare No. 1 is right at hand for immediate replacement during routine cleaning and maintenance of the gauge.

Spare No. 2 is ready for sudden emergencies. Provides quick replacement in case of breakage at night, for example, when your Industrial Distributor may not be open.

Play safe and smart on *all* your visual inspection problems. Call your Industrial Distributor, and order *extra* gauge glasses for all your vessels.

Remember: "ONE FOR THE GAUGE AND TWO FOR THE SHELF." And always specify hard-to-break CORNING®, PYREX® and MACBETH® gauge glasses. It's the economical way.

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

Application	Recommended Product
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
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Lubrication inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

CORNING GLASS WORKS
Corning, New York

Corning means research in Glass

New Equipment . . .

expanding slightly up to 1100 F. Completely immersed in a test furnace, at 1800 F., shrinkage is limited to about 1½ percent.

The material, called Kaylo-20, was developed by the new Owens-Illinois Technical Center. It has a pink color to distinguish it from standard Kaylo which is effective up to 1200 degrees. For additional information on this new insulation material . . .

Circle E6 on Postcard

Magnetic Amplifier . . . New "magnetic" industrial counting and control instruments operating at electronic speed and precision, yet offering the ruggedness and continuous-duty reliability of simple electromagnetic devices, now are in production by the Berkeley division of Beckman Instruments, Inc.

Heart of the revolutionary new instruments is a miniature wire-wound magnetic amplifier, epoxy resin-encapsulated in a tiny plastic cube measuring only 9/16 inch on all sides. Trademarked the "ferristor," this rugged electromagnetic component performs most former vacuum tube functions. Ferristors are non-ageing, immune to damage caused by shock, vibration, moisture or prolonged overloading. They produce little or no heat, permitting dust-tight enclosures on the new Berkeley magnetic instruments.

Circle E7 on Postcard

Armored Purge Meter . . . Fischer and Porter Company has announced the manufacture of an armored purge meter of all metal construction with a 1500 psi ASA pressure rating. The meter is suitable for use in chemical or processing installations where purging is required.

It was field-tested successfully in purge applications in the refinery industry for which it was specifically designed. The meter, Figure 245, uses a magnet and follower to indicate flow rate. A simple means of resetting the magnetic bond should it be lost due to a violent surge is provided.

The meter is available from stock in two sizes: (1) 25 gph water or 103 scfh of free air and (2) 80 gph water or 330 scfh of free air equivalent. It is not recommended for gas service below 60 psig. The temperature rating is to 400 F.

The meter is 7½ inches long with 1 7/16 inches outer diameter and connection size of ½ inch NPT (vertical). Scale graduation is 0 to 100 percent in 10 percent increments. All parts which come in contact with liquids are made of type 316 stainless steel.

Circle E8 on Postcard

Tube Cutter for the tube maintenance man's tool box has been developed by Airetool Manufacturing Company. This cutter is a push-in type internal tube cutter and is small enough to be easily carried out in the tool box.

Action of the cutting blades is produced by pushing the cutter into the tube which automatically opens the double cutter blades. Designed to be used more as a maintenance than as a production tool, the push type internal tube cutter should prove useful in a smaller plant operation where

TEMPORARY STRAINERS

Made by a skilled mechanic and not by "just some guy with a torch."

MAC-IRON Established 1901

REVOLUTIONARY CONSTRUCTION

Smooth, efficient contours . . . no weld "blob" around edge of ring. The flange is precision rabbeted into the ring joint gasket making deformation at that point impossible.

MAC-IRON offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges. A large stock on hand is maintained; special strainers made to specification.

Also producers of MAC-IRON Blinds and Spectacle Blinds (Figure 8). Available for use with various types of flanges in all pipe sizes and pressure ratings.

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Headquarters for PETROLEUM TESTING EQUIPMENT used by...

- Refineries
- Gasoline Plants
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Experienced engineers — Process, Mechanical, Electrical, Chemical, and Civil Engineers — assure sound engineering, design and erection, eliminating costly oversights and delays.

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Sound engineering, plus experienced construction personnel, plus plenty of good equipment assures economical, speedy construction. TELEPHONE, WIRE OR WRITE US BEFORE YOU BUILD OR REVAMP.

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are drop forged from highest quality forging bars. Accurately machined and finished to precision dimensions. Rigidly inspected throughout production and air tested under oil after completion to meet the highest standards of quality.

PERMANENTLY LUBRICATED NUT THREADS for quick and easy make and break. EXTRA HEAVY HANDLE BAR NUTS to withstand rugged use. "O" RINGS FORM PERFECT SEAL to retain pressures. "O" RINGS will not fall out. SEPARATE "O" RINGS are available for services and temperatures up to 500°F.

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New Equipment . . .

tube cutters are used, but where the speed and power of the larger internal cutter is not important.

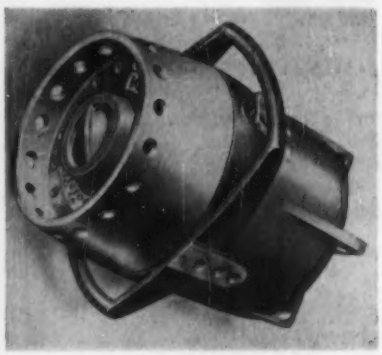
This cutter is intended to be used with an air or electric motor and works best on non-ferrous tubes in the small diameter range, sizes from 5/8-inch to 1-inch O.D. For complete information . . .

Circle E9 on Postcard

Platform Catalysts . . . Universal Oil Products Company has expanded its line of Platforming catalysts to include two tailored specifically for use in the production of gasolines of 98 leaded octane number and higher. The improved catalysts, when used for the production of high octane number gasolines, give increased gasoline yields, more hydrogen and less carbon than presently available reforming catalysts.

As in the case of earlier Platforming catalysts the improved catalysts, which will be known as Type R-7 and Type R-8, will be of low density and high activity. They will have the mechanical ruggedness characteristic of spherical shape, but will be smaller in size than present catalysts. One of them, Type R-8, available under special arrangement, will have a higher platinum content.

Circle E10 on Postcard



Radiographic Inspection Projector . . . a portable gamma ray projector for use in radiographic work has been placed on the market by The M. W. Kellogg Company. The projector is being made in three sizes.

The gamma ray projector is portable, and needs no electricity, no control board, no maintenance beyond replenishment of the radio-isotope, and is quite safe to operate. The projector is charged in a radio-isotope laboratory by inserting a small metal capsule that contains the proper amount of the radio-active istotope source. Gamma rays are projected from the small capsule through a shutter area to focus on the areas to be radiographically examined by the exposure of the film.

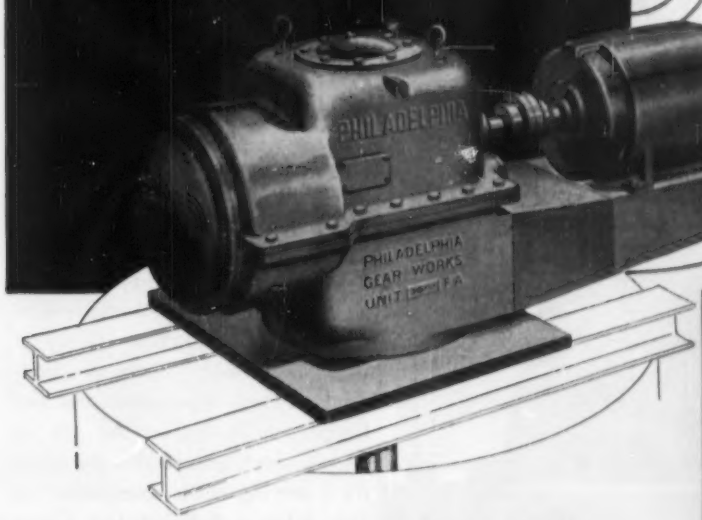
The gamma ray projector is shielded with lead, the thickness of which depends on the strength of the isotope to be employed. It has a lenseless shutter that can be opened and closed remotely.

These units are intended to simplify the non-destructive inspection of installations such as field-erected vessels, piping,

new

a complete line of

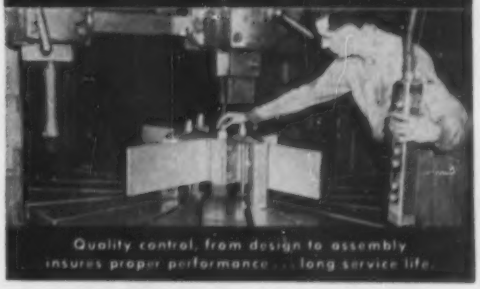
packaged **FLUID AGITATORS!**



Philadelphia Gear Works is proud to offer a new line of packaged fluid agitators . . . plus complete fluid agitation engineering service . . . plus field service —right in your plant—covering every phase of your particular fluid agitation applications. Our engineers are prepared to specify agitation to best meet your process requirements. As you know, Phillie Gear reducers for agitator drives have been meeting the most exacting standards of major processors for many years. We have the answers to your agitation problems. Let us assume the responsibility for every phase of your fluid agitator installations.

Complete production facilities assure prompt delivery . . . even with special agitator designs.

Phillie Gear manufactures every major component of the agitators, except motors and bearings.



Quality control, from design to assembly insures proper performance . . . long service life.

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LimiTorque Valve Controls

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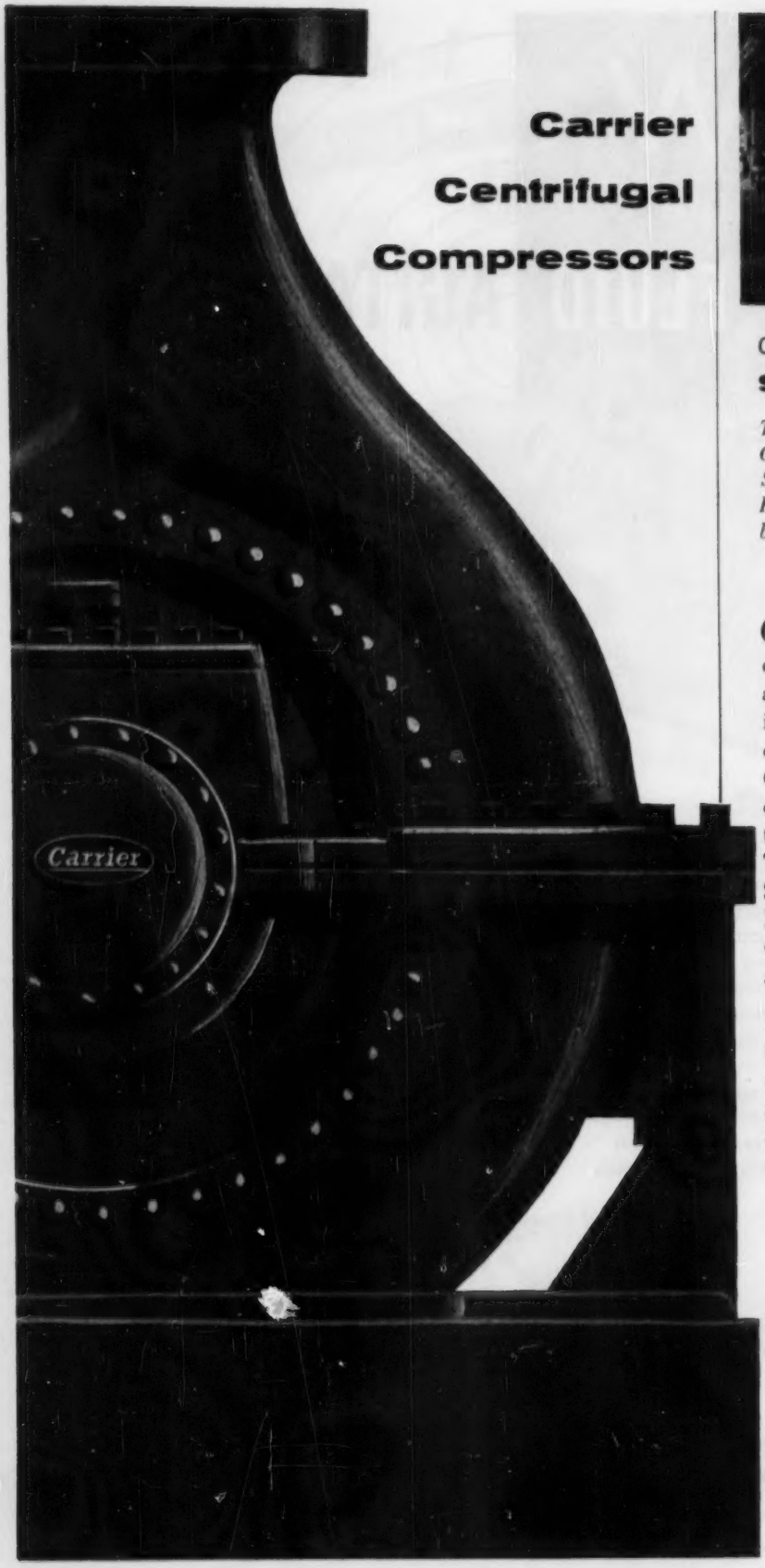
Carrier Centrifugal Compressors



on the job at

Shell Oil Company

These are two of the three Carrier Centrifugal Compressors on the job at Shell's Deer Park, Texas, refinery. Five more Carrier Compressors have been installed in Shell refineries.

Carrier makes a complete line of centrifugals for gas compression and refrigeration—up to 10,000 hp in a single unit. There are hundreds of these dependable, efficient Carrier machines on the job at dozens of refineries across the country — serving such companies as The Atlantic Refining Co., Cities Service Co., Esso Standard Oil Co., Humble Oil & Refining Co., Sinclair Oil Corp., The Texas Co. May we assist *you?*

If you'd like a copy of our informative booklet, "Centrifugal Compressors for Industry," please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

Carrier

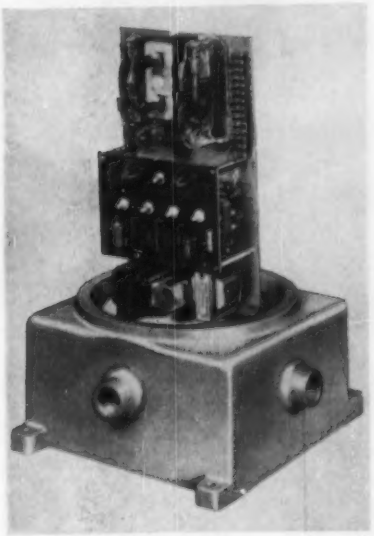
centrifugal compressors
refrigerating equipment

New Equipment...

casting and the like, through the use of gamma ray exposure of x-ray film to provide an internal picture of the structure being examined. Projectors are available with several gamma ray sources in several intensities which are selected for the class of work to be performed. For additional information, just circle the card.

This item supplements The M. W. Kellogg Company data on pages 505-512 of The Refinery Catalog, 22nd Edition.

Circle E11 on Postcard

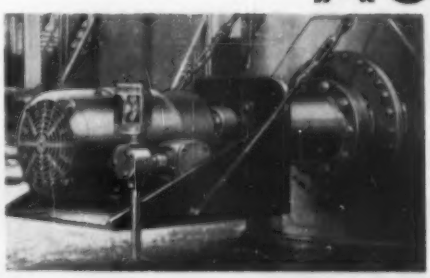


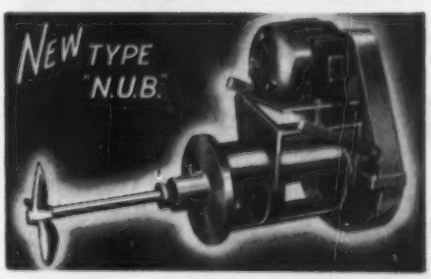
Remote Tank Temperature Reading . . . the Shand & Jurs Telepulse System of Remote Tank Gaging has been expanded to include a new Remote Temperature Reading System, called the ST-8900. This equipment can be installed as a separate, complete system for remote temperature reading, or in conjunction with the system for remote liquid level gaging. The temperature reading is transmitted by private or leased wires, carrier or Microwave and when added to a Remote Gaging System, it requires a minimum number of additional local lines, and shares some of the existing ones.

A start or trigger pulse is sent from the control or reading station. This pulse starts the transmitter, wherever it may be, on its indicating cycle. This involves three phases: First, a series of pulses that start the process of temperature reading at the particular transmitter selected; Second, another series of pulses positively identifying the transmitter and confirming its selection by sending appropriate signals back to the control station; and Third, a series of pulses sent back to the control station giving a direct indication of the temperature of the product being measured. These last pulses set us an indicator at the control station which shows an accurate temperature reading. At the conclusion of this three series of pulses, the temperature transmitter resets itself to readiness for repetition of another measuring cycle.

The normal span of reading is 130 F, with readings to the nearest 1 degree. Broader spans may be obtained in double

New! "International" SIDE ENTERING AGITATORS





Here are several good reasons why INTERNATIONAL excels in the primary essentials of efficient, economical and dependable performance.

1—LARGER SHAFTS—eliminating undue wear and stuffing-box leakage caused by rotational deflection.

2—LINE BORED STUFFING BOX AND BALL BEARING SEATS—insuring perfect, permanent alignment of shaft and bearings—self adjusting. Even when taken down and assembled, simply tighten bearing bolts to replace shaft in original concentric position. No special skill or tools are needed.

3—NEW SHUT-OFF CONNECTION which allows Stuffing Box repacking with a full head of liquid, without appreciable leakage or disturbing other parts of the assembly. A much quicker and simpler operation than with conventional types.

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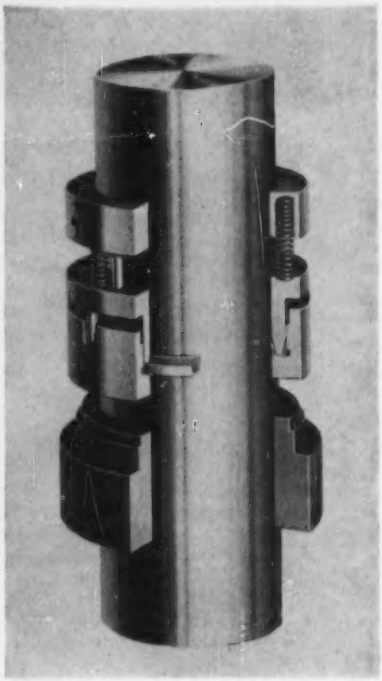

High Temperature Mechanical Seal . . . A rotary mechanical seal especially designed for high temperature service, has been announced by Durametallic Corporation. This new item is of Dura Seal line of products. This seal is intended to handle hot oils or hot water at temperatures up to 800 F. Both balanced and unbalanced seal assembly is included. The seal is generally stainless steel, with durable wearing faces and stainless steel U Ring Packings. The design allows for thermal expansion to insure efficient performance. The seals do not require stuffing box flushings, unless to control vapor pressures in the box, or to flush out any excessive coke formation which might be encountered in high temperature applications. For more information . . .

Circle E13 on Postcard

Control Signal Converter . . . a compact analog-to-digital converter, designed as a high-speed, high accuracy digitizing link for automatic logging and automatic input to digital computers and process controls, has been developed by Fischer and Porter Company. The new unit, type P Digi-Coder converts any process variable that can be represented by an electrical signal into a form suitable for directly operating electric typewriters, digital printers, tape or card punches, lamp banks or for initiating process control.

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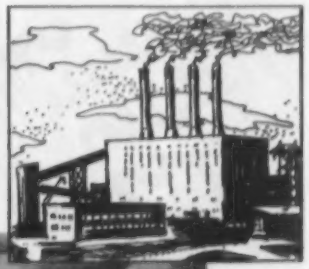

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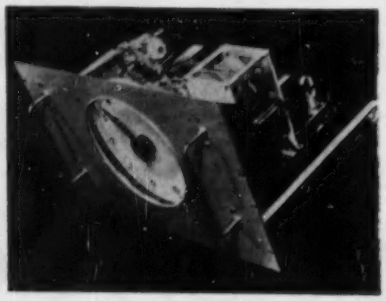

type amplifier and then fed to a null-balance potentiometer. The potentiometer servo mechanism supplies discrete shaft positions to the Digi-Coder section of the device.

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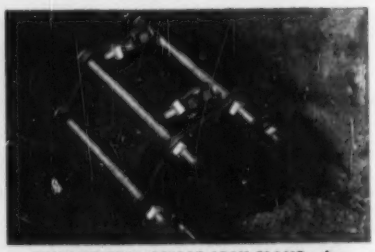

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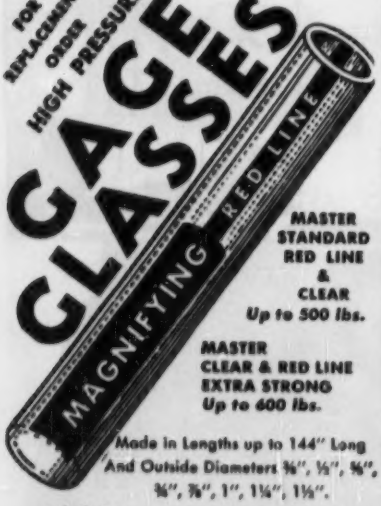

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FIG. 21—Lip Mold

FIG. 22—Standard

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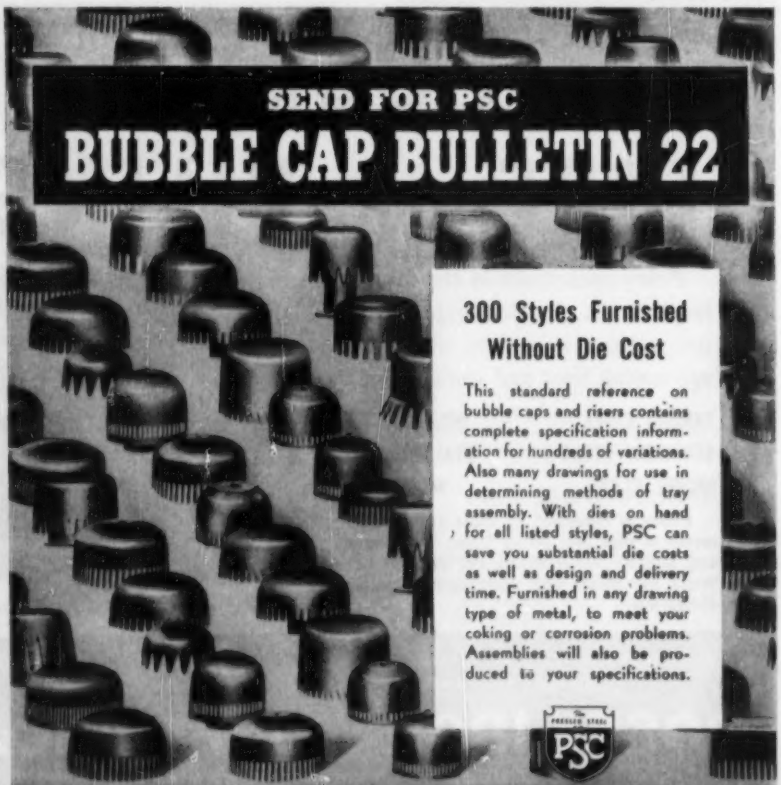

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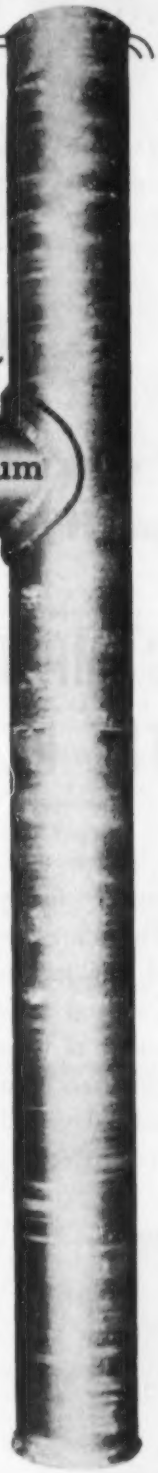

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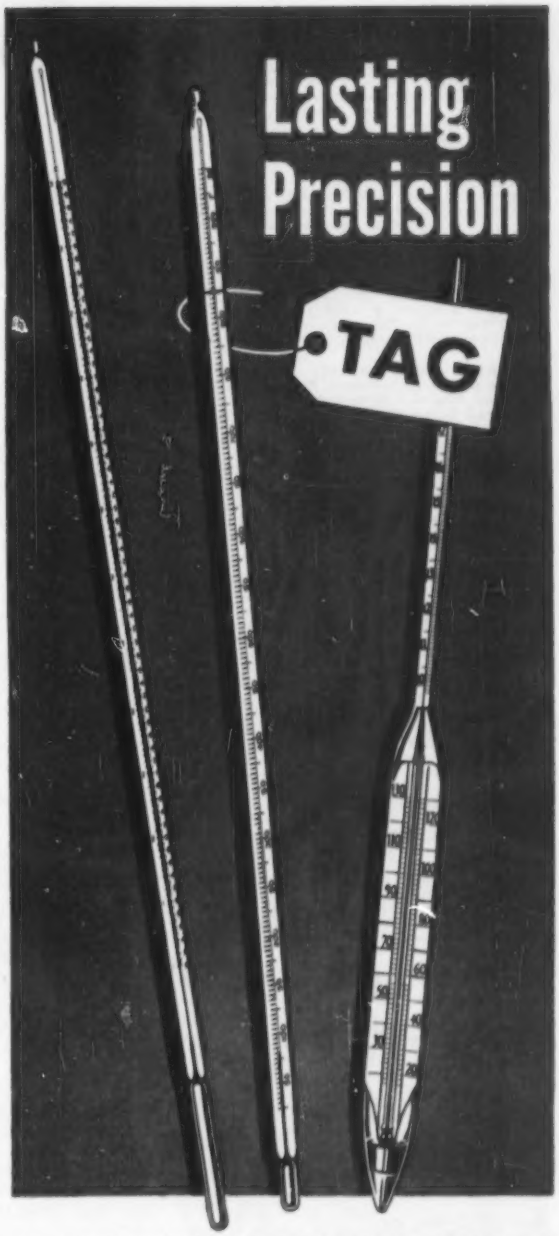

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Stainless Steel Data Sheet . . . The American Iron and Steel Institute has provided data in chart form for use as a general guide in the selection of stainless steels. The chart covers all standard types of these high quality steels and provides selected information on chemical composition, structure, general characteristics.

The steels are listed according to their AISI Standard type number. Thus, the user can tell at a glance the relationship among the various grades in a series or group.

While there are numerous trade names and numbers for the standard types of stainless, the use of standard AISI type numbers usually enables users to specify accurately the type of steel they require. These numbers are established to reflect industry practice and provide users with a single specification number which is recognized by all producers. For your copy of this useful chart . . .

Circle E15 on Postcard

Butterfly Valves . . . S. Morgan Smith Company has published the first half of what will be its complete catalog of butterfly valves for industrial use. The new catalog, in loose-leaf form contains a section on basic engineering data. A complete description of each valve with specifications, layout drawings and dimension of standard valves in each pressure rating. The catalog also contains sections on special metals and modifications available for extreme operating conditions, data on standard valve operators and positioners, and is coded to identify the R-S Standard stock valves in stock and standard valves on order.

This catalog is the result of an over-all standardization program begun early in 1954 by this company on its butterfly, cone and ball valves. For your copy of this catalog . . .

Circle E16 on Postcard

General Purpose Valves . . . Henry Vogt Machine Company has just published its new supplement No. 1 to Catalog F-9 covering their line of General Purpose Valves. The catalog is complete and includes dimensional details with complete data on trim size range and the like. For your copy . . .

Circle E17 on Postcard

Data Book . . . The 1956 edition of the booklet, "Physical Properties of Synthetic Organic Chemicals," has just been issued by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. This booklet is prepared annually as a helpful guide for chemists, engineers, purchasing agents, and laboratory workers. This 24-page edition features 32 new products available from Carbide and Carbon. It presents the latest data on more than 350 organic chemicals. The products are arranged by related groups with condensed data on applications. Physical properties are given in tabular form. An alphabetical index is included for easy reference.

Copies of the booklet (F-6136) are available . . .

Circle E18 on Postcard

Weld Fittings . . . Eisenwerk Kritzler of West Germany now offers new literature on its ASTM line of weld fittings including elbows, tees, reducers and caps. Information is printed in English and illustrates fully this line of material. To get your copy . . .

Circle E19 on Postcard

Valve Selection Chart . . . A new comprehensive Valve Selection Chart has just been issued by Hoke, Inc. The 18-inch x 24-inch wall chart provides tabular data on both vee point and blunt point needle valves as well as spring-closing and cam closing toggle valves. Included is a Corrosion Resistance Table as well as formulae for the proper method of valve sizing based on maximum flow desired. For your copy of this useful chart . . .

Circle E20 on Postcard

Pneumatic Regulators . . . A new eight-page booklet listing Conoflow Corporation's complete line of precision-made pneumatic regulator equipment is now available. The booklet covers filter-regulator combinations, filters and regulators, relays, purge assemblies and control panels. This descriptive, indexed bulletin is well-illustrated with cross section and dimension drawings, and gives typical applications of use. For your copy of this information . . .

Circle E21 on Postcard

Special Explosion Proof Fittings . . . Special condulet fittings made out of premium quality copper free aluminum have been cataloged for the first time by Crouse-Hinds Company in its bulletin 2681. The materials and construction details of these fittings are selected especially for severely corrosive locations such as ammonium nitrate plants, many acid plants and salt atmospheres.

The problems of designing equipment to resist this type of corrosive attack is twofold. First, it is necessary to eliminate the copper from the basic aluminum alloy. Second, it is necessary to eliminate many of the ordinary steel brass parts such as screws, washers, and operating shafts.

The bulletin lists a broad selection of both standard explosion proof condulets, plugs and recepticles, lighting fixtures, panelboards, switches, industrial patrol equipment and miscellaneous fittings. For your copy . . .

Circle E22 on Postcard

Gasoline Anti-Oxidant . . . Koppers Company, Inc., has just issued a new technical bulletin describing in detail the results of experiments and test with its anti-oxidant additive for gasoline, 2, 6-di-tertiary-butyl-paracresol (DBPC).

Entitled "DBPC and Impruvol 33," the new bulletin presents factual comprehensive data resulting from years of research on antioxidants to inhibit gum-formation in automotive and aircraft engines. Much of this technical data has not heretofore been published. This information is intended to assist the refiner seeking high quality improvement of his gasoline plus lower treating costs.

A new inhibiting practice involving the use of DBPC is outlined in detail in the 24-page bulletin. For your copy of this technical information . . .

Circle E23 on Postcard

Electrical Test Equipment . . A complete line of test equipment available from Weston Electrical Instrument Corporation is covered by their new catalog R36A. This catalog includes all instruments for servicing industrial electronic and electrical equipment. For this up-to-date catalog on electrical test instruments . . .

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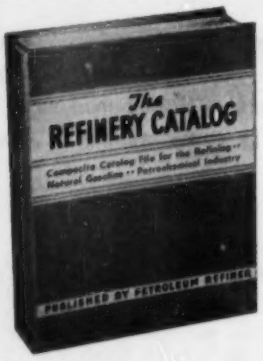
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2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.
3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

•

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PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS U. S. A.

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

PETROLEUM REFINER Readers' Service Card — December, 1955, Issue*

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25											

ADVERTISEMENTS—Circle page number of ad for more products information:

1	2	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
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259	260a	260b	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277
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329a	329b	330a	330b	330c	330d	331a	331b	332	337	338									

Name (Please Print) _____

Company _____ Position _____

Address _____

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

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PETROLEUM REFINER Readers' Service Card — **December, 1955, Issue***

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E25											

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329a	329b	330a	330b	330c	330d	331a	331b	332	337	338									

Name (Please Print) _____

Company _____ Position _____

Address _____

*NOV. ISSUE CARD EXPIRES FEB. 29, 1956 — Check Square for Extra Card ☐

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BOX 2608

HOUSTON 1, TEXAS U. S. A.

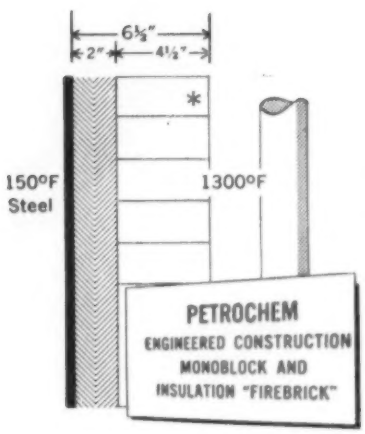
Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

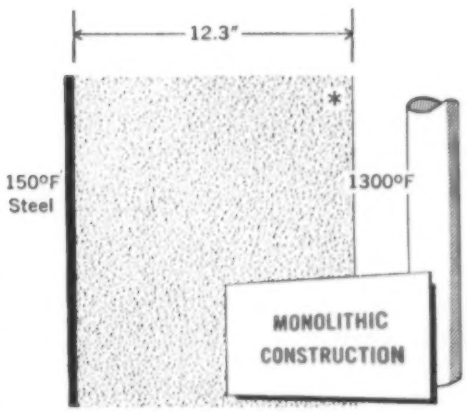
In furnaces as in processes compare the design to judge the advantages

As an example:

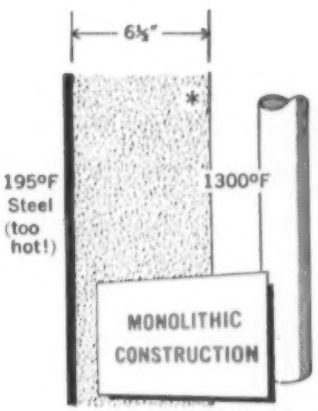
The wall construction of all Petrochem-Isoflow Furnaces is designed for 150°F maximum outside shell temperature.



1250 lbs. per 100 sq. ft.



5450 lbs. per 100 sq. ft.



2900 lbs. per 100 sq. ft.

*Based on B & W values.

The Petro-Chem design provides a thoroughly engineered wall construction. It is built with two tiers of monoblock supported on 18 inch centers and a circular arched wall of insulating firebrick. The inside of the steel shell is protected from the possibility of corrosion by a one-eighth inch thickness of Staylastic cement. This type of construction, independently supported monoblock and the circular arch of firebrick, bonded with Smoothset mortar, assures optimum efficiency and minimum maintenance.

The use of monoblock and insulating firebrick laid as a circular arch provides many advantages over a one-piece monolithic lining, including:

1—Low weight, 2—Low heat conductivity, 3—High hot crushing strength, 4—Low expansion coefficient, 5—Resilient compressible backing, 6—Long life, 7—Nil maintenance.

Also, this construction has low heat storage capacity, speeds both heating and cooling. Its light weight requires less concrete foundations and steel supports.

Compare and your judgment will affirm
Petrochem-Isoflow Furnaces are Most Efficient by any Comparison

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES: Rawson & Co., *Houston* • Wm. H. Mason Co., *Tulsa* • Lester Oberholtz, *Los Angeles* • Faville-Levally, *Chicago* • D. D. Foster, *Pittsburgh* • Turbex, *Philadelphia* • Flagg, Brackett & Durgin, *Boston*

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Plate 864

Plate 807-A

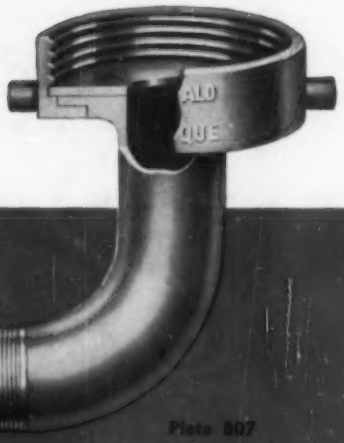

Plate 807

Plate 860-N

Plate 917

EVERY McDONALD PRODUCT GIVES THE OIL INDUSTRY SOMETHING "EXTRA".

From products of simplest design to the most intricate planning on the drawing board, following through to the ultimate of years of service McDonald equipment shows its ability to take it. Built into our equipment is not only ruggedness but also the newest and best features which men in the field tell us they want and need. It's toward this end that our engineers and production men are constantly working.

A good example of this is Plate 864, illustrated above. This cover is used when loading tank cars with gasoline — reduces evaporation losses — eliminates danger of sparks — permits loading rain or shine. Made of aluminum — permits easy handling by one man. Covers are equipped with "Peep Hole Glasses" in order that contents of car may be watched while loading.

Also produced by McDonald for tank car work are Plates 807, 807-A and 917. As you can see, the difference is the 90 and 45 degree angles, whichever you desire, with Plate 917 featuring female outlet threads. All 3 of these Tank Car Reducer Couplings are made of bronze and come equipped with a composition gasket and forged steel spanner wrench. They are offered in sizes from 5 x 2 inches up to 5 x 4 inches, with Plate 917 in sizes from 5 x 2 inches to 5 x 3 inches.

Also illustrated is Plate 860-N, a 4" flanged, non-rising stem Expansion Relief Gate Valve. When pressure in a line builds up, the disc in the by-pass opens, allowing the pressure in the line to equalize itself with that in the tank. Valve is set at 20 pounds pressure but this may be set as desired.

For further information on any of the above items or on our complete line, please write the A. Y. McDonald Mfg. Co., Dubuque, Iowa.

HOME OF THE SWING JOINT

• OIL EQUIPMENT •

EST. 1856

McDonald